PHOTOGRAPH THIS SHEET

AD-A227 068

DTIC ACCESSION NUMBER

LEVEL

DTIC FILE COPY

INVENTORY 1

IRP Phase II Field Eval Eglin AFB
Sept 1984

DOCUMENT IDENTIFICATION

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR
NTIS GRA&I ☒
DTIC TRAC ☐
UNANNOUNCED ☐
JUSTIFICATION

BY
DISTRIBUTION/
AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DTIC
ELECTE
OCT 02 1990
S E D
Co

DATE ACCESSIONED

DATE RETURNED

90 09 13 032

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

DTIC FORM 70A APR 87 — DOCUMENT PROCESSING SHEET — PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED

ORDER NO. 006

SEPTEMBER 1984
FINAL

INSTALLATION RESTORATION PROGRAM

For

EGLIN AFB, FLORIDA

PHASE II — FIELD EVALUATION

Prepared For
UNITED STATES AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY
AEROSPACE MEDICAL DIVISION (AFSC)
BROOKS AFB, TEXAS 78235

Water and Air Research, Inc.
Consulting Environmental Engineers and Scientists

INSTALLATION RESTORATION PROGRAM
FOR EGLIN AFB, FLORIDA
PHASE II--FIELD EVALUATION

Prepared for:

UNITED STATES AIR FORCE
Occupational and Environmental Health Laboratory
Aerospace Medical Division
Brooks AFB, Texas 78235

Prepared by:

WATER AND AIR RESEARCH, INC.
Gainesville, Florida

September 1984

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER 33615-81-D-4007-005 / 2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Installation Restoration Program for Eglin Air Force Base Phase II--Field Evaluation	5. TYPE OF REPORT & PERIOD COVERED Final report August 1982 - September 1984
	6. PERFORMING ORG. REPORT NUMBER 7166 (060)
7. AUTHOR(s) J.H. Sullivan, W.D. Adams, C.R. Fellows, R.D. Baker, and J.A. Steinberg	8. CONTRACT OR GRANT NUMBER(s) 33615-81-D-4007
9. PERFORMING ORGANIZATION NAME AND ADDRESS Water and Air Research, Inc. P.O. Box 1121/6821 SW Archer Road Gainesville, Florida 32602	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS United States Air Force Occupational and Environmental Health Laboratory Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas 78235	12. REPORT DATE September 1984
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DDT, dissolved organic carbon, Eglin AFB, groundwater, herbicides, Installation Restoration Program, oil and grease, pesticides, pH, phenolics, purgeable organics, sand and gravel aquifer, specific conductance, surface water, total organic carbon, total organohalides

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Water and Air Research, Inc. (WAR) conducted the Phase II study of the Installation Restoration Program (IRP) for Eglin Air Force Base (AFB) from the Fall of 1982 through the Summer of 1983. This study implemented recommendations for further study at seven sites identified in the Phase I report. The Phase I recommendations were modified by input from WAR and the Occupational and Environmental Health Laboratory (OEHL). WAR's charge was to assess the presence or absence of contamination at the seven sites

20. ABSTRACT (continued)

and to assess the potential for contaminant migration from the sites to the off-base environment. The Phase II study consisted of a preliminary site visit, monitor well installation, sample collection on three separate occasions, laboratory analyses, aquifer tests, data assessment, report preparation, and development of conclusions and recommendations.

Study sites at Eglin AFB consisted of six landfills and one explosive ordnance disposal (EOD) training range. There were four landfills studied at Eglin Main: D-1, D-2, D-3, and D-7. There were two study sites at Hurlburt Field. These included one landfill (D-26) and the EOD training range (D-41). There was one study site on Santa Rosa Island (Landfill D-40).

All monitor wells were installed in the sand and gravel aquifer which is a water table aquifer. In the Eglin AFB area, the sand and gravel aquifer is not used for large-scale water supplies and there are no potable water supply wells completed in the sand and gravel aquifer on Eglin AFB. The sand and gravel aquifer varies from approximately 50 feet thick at Eglin Main to approximately 150 feet thick at Hurlburt Field and Santa Rosa Island. The Pensacola Clay Confining Bed underlies the sand and gravel aquifer; its thickness varies from approximately 250 feet at Eglin Main to over 400 feet at Hurlburt Field and Santa Rosa Island. The principal source of potable water in the area, the Floridan Aquifer, underlies the Pensacola Clay Confining Bed throughout the study area.

There is no consistent evidence of any immediate threat to human health or the environment at Eglin AFB. However, there is evidence of some contamination downgradient from four landfills. This is indicated primarily by increases in specific conductance and, in some instances, by increases in organic carbon or total organic halogens (TOX). Where some contamination is indicated, the threat to human health and/or the environment is considered to be low due to the absence of wells in the potentially contaminated area, and/or limited movement of contaminants into surface waters. Additional study and improved landfill maintenance is recommended at Landfills D-1, D-3, D-7, and D-26.

There was no evidence of significant contamination at Landfills D-2 and D-40 and Site D-41. No further study is recommended for these sites. However, at Site D-41, additional cover material and establishment of suitable vegetative cover is recommended.

TABLE OF CONTENTS

LIST OF TABLES
(Page 1 of 2)

LIST OF TABLES
(Page 2 of 2)

LIST OF FIGURES

SUMMARY

SUMMARY

Water and Air Research, Inc. (WAR) conducted the Phase II study of the Installation Restoration Program (IRP) for Eglin Air Force Base (AFB) from the Fall of 1982 through the Summer of 1983. This study implemented recommendations for further study at seven sites identified in the Phase I report. The Phase I recommendations were modified by input from WAR and the Occupational and Environmental Health Laboratory (OEHL). WAR's charge was to assess the presence or absence of contamination at the seven sites and to assess the potential for contaminant migration from the sites to the off-base environment. The Phase II study consisted of a preliminary site visit, monitor well installation, sample collection on three separate occasions, laboratory analyses, aquifer tests, data assessment, report preparation, and development of conclusions and recommendations.

Study sites at Eglin AFB consisted of six landfills and one explosive ordnance disposal (EOD) training range. There were four landfills studied at Eglin Main: D-1, D-2, D-3, and D-7. There were two study sites at Hurlburt Field. These included one landfill (D-26) and the EOD training range (D-41). There was one study site on Santa Rosa Island (Landfill D-40).

Laboratory analyses for the samples were selected after consideration of the suspected types of wastes reported in the Phase I study (Tables S-1 and S-2).

All monitor wells were installed in the sand and gravel aquifer which is a water table aquifer. In the Eglin AFB area, the sand and gravel aquifer is not used for large-scale water supplies. The sand and gravel aquifer varies from approximately 50 feet thick at Eglin Main to approximately 150 feet thick at Hurlburt Field and Santa Rosa Island. The Pensacola Clay Confining Bed underlies the sand and gravel aquifer; its thickness varies from approximately 250 feet at Eglin Main to over 400 feet at Hurlburt Field and Santa Rosa Island. The principal source

Table S-1. Phase II-Field Evaluation Study Sites at Eglin AFB

Site	Site Name	Period of Operation	Area Size (Acres)	Suspected Types of Wastes	Estimated Quantity of Waste (Acre-Ft)
EGLIN MAIN					
D1	Eglin Main Base Landfill	1940's-early 60's	100	Construction rubble, tires, wires, hydraulic fuels, waste oils, waste solvents, septic tank sludges, general refuse, sanitary wastes, PCB capacitors, pesticide containers and pesticides	1,000
D2	Eglin Main Base Landfill Near Commissary	Early 60's-72/73	50	Construction rubble, tires, wood, hydraulic fuels, septic tank sludges, garbage, hardfill, waste solvents, general refuse, PCB capacitors, waste fuel oil, pesticide containers, pesticides, metal plating sludges	200-350
D3	Eglin Main Base Landfill Near Cobbs Overrun	1972/73-1978	30-35	Hardfill (tires, wire, spools, mattresses, concrete), general refuse, septic tank sludges, oil/water separator sludges.	100-150
D7	Receiver Area Disposal Site	1970's	10	Hardfill (tires, wire, spools, mattresses, concrete), asbestos insulation, PCB capacitors, PCB transformers, electrical components, paint shop wastes, aqueous film-forming foams (AFFF), waste fuel oils, solvents, septic tank pumpings, Federal Prison garbage, waste pesticides and containers	80
HURLBURT FIELD					
D26	Sanitary Landfill	1972-1979	5	Rubbish, trash, tires, boards, old building materials, concrete, asphalt, empty drums, waste treatment plant sludge, solvent degreasers, waste oils, pesticide containers, PCB capacitors	25-30
D41	EOD Training Range	1950's-1960's	1-2	Napalm, bomb fuzes, small arms ammunition, bulk explosives	
SANTA ROSA ISLAND					
D40	A-11 Disposal Site	1960's-1970's	0.5	Hardfill, metal spools, drums of waste oil, solvent drums with solvent	6-7

Source: Christopher et al., 1981.

Table S-2. Schedule of Samples for Eglin AFB, November 1982 and February 1983

Station	GWCI*	Metals†	Phenolics	Oil & Grease	Organo-chlorine Pesticides/ PCBs	Herbicides**	Purgeable Organics
D-1A	G	G	G	G	G	G	G
D-1B	G	G	G	G	G	G	G
D-1C	G	G	G	G	G	G	G
D-1D	G	G	G	G	G	G	G
D-1G	L	L	L	L	L	L	L
D-1E	S	S	S	S,Sd	S,Sd	S,Sd	S
D-1F	S	S	S	S,Sd	S,Sd	S,Sd	S
D-2A	G	G	G	G	G	G	G
D-2B	G	G	G	G	G		G
D-2C	G	G	G	G	G		G
D-2D	G	G	G	G	G		G
D-2E	S	S	S	S,Sd	S,Sd	Sd	S
D-3A	G			G			
D-3B	G			G			
D-3C	G			G			
D-3D	G			G			
D-3E	S			S,Sd			
D-3F	S			S,Sd			
D-7A	G		G	G	G	G	G
D-7B	S		S	S	S	S	S
D-7C	S		S	S	S	S	S
D-7D	S		S	S	S	S	S
D-3B	S		S	S	S	S	S
D-3C	S		S	S	S	S	S
D-3D	S		S	S	S	S	S
D-26A	G		G	G	G	G	G
D-26B	G		G	G	G	G	G
D-26C	G		G	G	G	G	G
D-26D	G		G	G	G	G	G
D-26E	S		S	S,Sd	S,Sd	S,Sd	S
D-40A	G		G	G			G
D-40B	G		G	G			G
D-40C	G		G	G			G
D-40D	G		G	G			G
D-41A	G		G	G			G
D-41B	G		G	G			G
D-41C	G		G	G			G
D-41D	G		G	G			G
D-41E	S, Sd		S,Sd	S,Sd			S,Sd

*GWCI = pH, specific conductance, TOC, and TOX.
†Metals = As, Cd, Cr, Co, Pb, Hg, Ni, Ag, Zn.
**Herbicides = 2,4-D; 2,4,5-T; Silvex.
G = groundwater sample.
L = leachate sample.
S = surface water sample.
Sd = sediment sample.

of potable water in the area, the Floridan Aquifer, underlies the Pensacola Clay Confining Bed throughout the study area.

There is no consistent evidence of any immediate threat to human health or the environment at Eglin AFB. However, there is evidence of some contamination downgradient from some landtills. This is indicated primarily by increases in specific conductance and, in some instances, by increases in organic carbon or total organic halogens (TOX). Low concentrations of dichloro-diphenyl-trichloro-ethane (DDT) were found in a few samples. Where some contamination is indicated, the threat to human health and/or the environment is considered to be low due to the absence of wells in the potentially contaminated area, and/or limited movement of contaminants into surface waters. As is typical of investigations of potential groundwater contamination, the results contain a number of apparent anomalies such as inconsistent patterns of contamination.

As noted earlier, the three main indicators of contamination at Eglin AFB are specific conductance, organic carbon, and TOX. Unfortunately, all three of these are measures of entire classes or groups of potential contaminants and give no direct indication of the specific compounds involved. This makes precise quantification of the seriousness of the contamination in terms of human health or the environment difficult, if not impossible, without further more specific analyses.

There was no evidence of significant contamination at Landfills D-2 and D-40 and Site D-41. No further study is recommended for these sites. However, at Site D-41, additional cover material and establishment of suitable vegetative cover is recommended.

WAR recommends additional study and/or remedial action at Landfills D-1, D-3, D-7, and D-26. These sites are listed in order of decreasing priority. The recommended actions are as follows:

Landfill D-1--Monitor, on a semiannual basis, sediment and edible fish species in Weekly Pond for DDT residues.

Landfill D-3--Monitor, on a semiannual basis, surface water and groundwater to determine the extent and nature of organohalide contamination. Depending on the initial results, monitoring may need to be extended to edible fish species in Jack Lake. Remove and properly dispose of the small quantity of material that has been disposed of at this site since closure and post signs prohibiting future dumping.

Landfill D-7--Monitor, on a semiannual basis, surface waters and sediments adjacent to the landfill to determine the extent and nature of phenolics and pesticide contamination. Depending on the initial results, monitoring may need to be extended to edible fish species in the area. Improve site maintenance by mowing and erosion control.

Landfill D-26--Monitor, on a semiannual basis, surface water and groundwater to determine the extent and nature of organohalide and pesticide contamination. Depending on the initial results, monitoring may need to be extended to edible fish species in the area. Improve site maintenance by mowing and erosion control.

The results of the monitoring outlined above should be used to determine if the:

1. Monitoring should be increased either in (a) frequency, (b) type of analyses performed on the samples, or (c) type of samples taken.
2. Monitoring should be continued unchanged.
3. Monitoring should be discontinued.

In addition to the recommendations for specific sites outlined above, it is recommended that any future siting of potable wells in the area be done with full knowledge and consideration of the potential hazard that abandoned landfills pose to such installations.

1.0 INTRODUCTION

1.0 INTRODUCTION

The U.S. Air Force (USAF) OEHL assigned WAR the task of determining whether environmental contamination of groundwater and surface water had resulted from waste handling and disposal practices at seven sites on Eglin AFB, Florida (Figures 1 and 2). WAR performed this study within the context of the IRP as the Phase II Field Investigation. Christopher et al. (1981)[1] performed the Phase I Records Search study which identified and evaluated past waste disposal sites at Eglin AFB. WAR (1981, unpublished) performed the Phase II Presurvey in which the Phase I report recommendations were evaluated and modified. The scope of the present study was defined during discussions between WAR and OEHL in August and September 1982.

1.1 HISTORICAL SUMMARY

The present Eglin AFB started on June 14, 1935 as the Valparaiso Bombing and Gunnery Range, a subpost of Maxwell Field, Alabama. It was redesignated Eglin Field on August 4, 1937. Eglin AFB has grown from its start on donated land to an installation of approximately 464,000 acres (Figure 2). It now serves as headquarters for Air Force Systems Command's Armament Division whose primary mission is the development, testing, and acquisition of all conventional armament for the USAF.

According to the Phase I report, eight classes of activities at Eglin AFB produced potentially hazardous wastes (Christopher et al., 1981). These were:

1. Industrial operations (shops),
2. Research and development labs,
3. Fuels management,
4. Herbicide and other pesticide applications,
5. Demilitarization of munitions,

[1]Christopher, W.G. et al., 1981. Installation Restoration Program, Phase I Records Search, Hazardous Materials Disposal Sites, Eglin AFB, Florida. Prepared for United States Air Force AFESC/DEV, Tyndall AFB, Florida. Contract No. F08637-80-G-0009-002.

6. Fire control training,

7. Hazardous waste storage, and

8. Weapons testing.

Wastes generated and disposed of as a result of these activities included oils; fuels; solvents; cleaners; pesticides; battery acid; paint; photo chemicals; polychlorinated biphenyls (PCBs); and munitions compounds (napalm, trinitrotoluene, etc.).

Table 1 summarizes the Phase I data on the size, suspected wastes, and the period of operation of each of the seven sites considered in this study. The suspected wastes for each site were considered in preparing the sample schedule (Table 2) for the Phase II study.

Phase IIb--Field Evaluation consisted of the following field activities: sample site selection (August 1982), monitor well installation (October and November 1982), monitor well survey (February 1983), sample collection (November 1982, and February and July 1983), and single-well aquifer tests (April 1983). Subsequent activities included laboratory analyses of soil and water samples, data assessment, and report preparation.

1.2 STUDY AREAS

Six of the areas selected for the Phase II evaluation are former landfills; the seventh is an EOD training range. Of the seven sites, four (Landfills D-1, D-2, D-3, and D-7) are at Eglin Main (Figure 3, Table 1), two (Landfill D-26 and Site 41) are at Hurlburt Field (Figure 4, Table 1), and the remaining site (Landfill D-40) is on Santa Rosa Island, south of Hurlburt Field (Figure 4, Table 1).

1.2.1 Eglin Main

1.2.1.1 Landfill D-1--Landfill D-1 was given the highest priority ranking in the Phase I report and is the largest of all the sites. Four monitor wells (D-1A through D-1D), two surface water sediment stations (D-1E and D-1F), and one leachate station (D-1G) are associated with this site (Figure 3, Table 2). At all sites, the well labeled "A" is hydraulically upgradient of the landfill. Receiving waters adjacent to Landfill D-1 are Choctawhatchee Bay and Weekly Pond. Weekly Pond has been separated from the rest of Weekly Bayou by a small control structure. Prior to and during the Phase IIb field study, Weekly Pond was drained for maintenance dredging and control structure repairs. Weekly Pond and Choctawhatchee Bay are both used for recreational fishing.

1.2.1.2 **Landfill D-2**--This site ranked second highest on the list for further study in the Phase I report. Four wells (D-2A through D-2D) and one surface water/sediment station (D-2E) were used at Landfill D-2 (Figure 3, Table 2). Groundwater flow from this site may be expected to migrate west to Bear Creek (Lower Memorial Lake), south to Choctawhatchee Bay, and east toward a drainage ditch that flows into Jack Lake.

1.2.1.3 **Landfill D-3**--Landfill D-3 was given the fourth highest priority ranking in the Phase I report. Four wells (D-3A through D-3D) and two surface water/sediment stations (D-3E and D-3F) were used to monitor this landfill (Figure 3, Table 2). Station D-3E is downstream on the creek northwest of the landfill. The stream flows into Jack Lake, a freshwater lake used for recreational fishing. Station D-3F is in a pond located between Well D-3B and the creek.

1.2.1.4 **Landfill D-7**--Landfill D-7 was the seventh ranked site in the Phase I report. One well (D-7A) and three surface water stations (D-7B through D-7D) were used at this site (Figure 3, Table 2). This landfill is a delta-like volume of debris approximately 60 feet thick, dumped into a steephead whose waters are tributary to Tom's Bayou. The water at the base of the fill has been impounded by several beaver dams.

1.2.2 Hurlburt Field

1.2.2.1 **Landfill D-26**--This landfill was the third highest priority site in the Phase I report. Four wells (D-26A through D-26D), one surface water/sediment station (D-26E), and one surface water station

(D-26F) were used to monitor this landfill (Figure 4, Table 2). Groundwater and surface water flow at Landfill D-26 is northerly toward the East Bay Swamp.

1.2.2.2 Site D-41--The EOD training range ranked fifth highest priority in the Phase I report. Four wells (D-41A through D-41D) and one surface water/sediment station (D-41E) were used to monitor this site (Figure 4, Table 2). Station D-41E is in a ditch which runs north from the center of the disposal area toward East Bay Swamp. Groundwater flow is also toward East Bay Swamp.

1.2.3 Santa Rosa Island

1.2.3.1 Landfill D-40--This landfill was the sixth highest ranked site in the Phase I report. Wells D-40A through D-40D were used to monitor this landfill (Figure 4, Table 2). Santa Rosa Sound is the closest surface water body.

1.3 PROJECT STAFF

WAR's project staff consisted of the following people whose resumes are included as Appendix D:

W.D. Adams, M.S.--Hydrogeologist
R.D. Baker, B.S.--Chemist
C.R. Fellows, M.S.--Chemist
J.A. Steinberg, Ph.D., P.E.--Water Resources Engineer
J.H. Sullivan, Ph.D., P.E.--Environmental Engineer

2.0 ENVIRONMENTAL SETTING

2.0 ENVIRONMENTAL SETTING

2.1 CLIMATE

Northwest Florida's climate is classified as humid, subtropical. Latitude and the proximity of the Gulf of Mexico are the chief factors affecting the area's climate (Bradley, 1972)[2].

During the hottest months (July and August), average daily temperatures at Niceville range from a low of approximately 70°F to a high of 88°F. During the months of December through February, daily temperatures may be as low as 18°F or as high as 74°F with the average around 50°F (Barr et al., 1981)[3]. The average annual temperature at DeFuniak Springs was approximately 69°F for the period 1931 to 1960 (Bradley, 1972).

The seasonal distribution of rainfall in northwest Florida is highest during the summer and from late winter to early spring, the summer rainy season being the wetter of the two (Bradley, 1972; Barr et al., 1981). October is typically the driest month. Summer rain is produced by brief, intense, convective storms whose effects tend to be localized. Winter rainfall is produced by the interaction of warm and cold air masses as frontal systems move through the area. The effects of winter storms are generally felt throughout the area.

In a typical year, more than 60 inches of rain falls in the study area. Average annual rainfall at Niceville during 1941 to 1979 was 64.1 inches (Barr et al., 1981). During the period 1931 to 1960, average annual rainfall was 62.5 inches at Niceville and 66.3 inches at DeFuniak Springs (Bradley, 1972).

---

[2] Bradley, J.T. 1972. The Climate of Florida. Reprinted in: Climates of the States, Vol. 1. 1974. Water Information Center. Port Washington, New York.

[3] Barr, D.E., A. Maristany, and T. Kwader. 1981. Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida--Summary Investigation. Northwest Florida Water Management District. Water Resources Assessment 81-1. 41 p.

Although average rainfall is approximately 62 to 66 inches, periods of both low rainfall and extremely wet years occur in northwest Florida. The years 1954 to 1956 were a time of low rainfall throughout the state of Florida. During this period, annual rainfall at Niceville varied from just over 30 inches in 1954 to approximately 50 inches in 1956 (Barr et al., 1981). In the wettest years, rainfall may exceed 80 inches.

2.2 PHYSIOGRAPHY AND TOPOGRAPHY

Brooks (1981)[4] classified the portions of Eglin AFB considered in this study (Eglin Main, Hurlburt Field, and Santa Rosa Island) into two physiographic subdivisions. Both are within the Southern Pine Hills District of the Gulf Coastal Plain Section of Florida and are separated by a scarp whose toe elevation varies between 20 and 25 feet above mean sea level (msl). The Coastal Strip subdivision is seaward of the scarp and consists of late Pleistocene and Recent Ages lagoonal and barrier island features. The Western Sand Hills of the Eglin Ridge are on the high side of the scarp; this area consists of thick sand deposits.

At Eglin Main, elevations below the scarp vary from 22 feet msl to less than 5 feet msl along Choctawhatchee Bay and other bodies of water. Elevations on the high side of the scarp range from 50 feet msl or more to 86 feet msl [Destin and Ft. Walton Beach Quadrangles, U.S. Geological Survey (USGS) 7.5 minute topographic maps]. Surface drainage at Eglin Main is toward Choctawhatchee Bay or to its tributaries.

Elevations at Hurlburt Field vary from approximately 15 feet msl to approximately 37 feet msl (Mary Esther Quadrangle, USGS 7.5 minute topographic map). In this vicinity, the scarp has a toe elevation of 20 feet msl, and the scarp is less distinct than at Eglin Main. Surface drainage at Hurlburt Field is toward either Santa Rosa Sound on the south or the East Bay Swamp on the north.

---

[4]Brooks, H.K. 1981. Physiographic Divisions of Florida. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Santa Rosa Island is a barrier island consisting of an extensive dune field between Santa Rosa Sound and the Gulf of Mexico. Elevations generally vary between sea level and 15 feet msl, although a few dunes are 25 to 50 feet msl.

2.3 GEOLOGY

For the purposes of this study, the geologic units of interest are those which constitute the two uppermost aquifers and the confining unit between them. These strata are of Middle Eocene to Recent Age and consist chiefly of limestone and unconsolidated clay, and sand (Barr et al., 1981). The stratigraphic units beneath Eglin AFB, Florida are summarized in Table 3. From land surface downward they include undifferentiated Pliocene to Recent Age sands, the Pliocene (Miocene?) Citronelle Formation, the Miocene Alum Bluff Group, Bruce Creek Limestone, the Tampa Stage Limestones, the Oligocene Chickasawhay Limestone, and the Eocene Ocala Group (Barr et al., 1981). The dip of these formations is south-southwest at a rate that varies from approximately 15 feet per mile to 25 feet per mile (Barr et al., 1981).

2.4 HYDROGEOLOGY

Three hydrogeologic units are of interest in the area of Eglin AFB. These are the sand and gravel aquifer, the Pensacola Clay Confining Bed, and the Floridan Aquifer (Barr et al., 1981). Table 3 summarizes the stratigraphy, thickness, lithology, and hydrologic characteristics of each. It should be emphasized that a hydrogeologic unit (e.g., sand and gravel aquifer, Pensacola Clay Confining Bed, etc.) is composed of a collective body of rock or unconsolidated sediments that share similar water-transmitting properties. Therefore, any given hydrogeologic unit may be composed of one or more stratigraphic units (formations, groups, etc.), and the stratigraphic units comprising a given hydrogeologic unit may vary from location to location. For example, in the vicinity of Eglin AFB the sand and gravel aquifer may consist of the Citronelle Formation and/or Pliocene to Recent sands, but west of Hurlburt Field near the Santa Rosa County-Okaloosa County line, the sand and gravel aquifer may be composed of Pliocene to Recent Age sands, the Citronelle Formation, and Miocene coarse clastics (Barr et al., 1981). The stratigraphic composition of the Pensacola Clay Confining Bed also varies and depending upon location, it may or may not include the Pensacola Clay (stratigraphic unit).

The sand and gravel aquifer varies from approximately 50 feet thick at Eglin Main to approximately 150 feet thick at Hurlburt Field and Santa Rosa Island. The underlying Pensacola Clay Confining Bed increases from approximately 250 feet thick at Eglin Main to over 400 feet thick at Hurlburt Field and Santa Rosa Island (Barr et al., 1981).

Virtually all groundwater withdrawals in the vicinity of Eglin AFB and Hurlburt Field are from the upper part of the Floridan Aquifer; however, a minor quantity is taken from the sand and gravel aquifer (Barr et al., 1981). In a study of the sand and gravel aquifer in southern Okaloosa and Walton Counties, Hayes and Barr (1983)[5] inventoried 96 wells completed in the sand and gravel aquifer. While this inventory was not exhaustive, it probably represents a large enough sampling to indicate the general usage pattern of water drawn from the sand and gravel aquifer in southern Okaloosa and Walton Counties. Thirty-nine of the wells were listed as unused, and the use of ten wells was unknown. The most frequent known use (21 wells) was for irrigation which was followed by domestic use (14 wells), public supply (11 wells), and air conditioning (1 well).

None of the domestic supply wells were shown as being either downgradient of or in the vicinity of any of the Phase II study sites. One of the wells listed as a public supply well is located at the scout camp (Building 1701) (Hayes and Barr, 1983) which is downgradient of Landfill D-2 at Eglin Main. WAR discussed the present use of this well

---

[5]Hayes, L.R. and D.E. Barr. 1983. Hydrology of the Sand-and-Gravel Aquifer, Southern Okaloosa and Walton Counties, Northwest Florida. U.S. Geological Survey. Water Resources Investigations Report 82-4110.

with officials at Eglin AFB and was assured that all water for human consumption at Eglin Main and Hurlburt Field is withdrawn from the Floridan Aquifer (Hartman and Postrozny, 1984)[6]. The well that Hayes and Barr (1983) listed as a public supply well at the scout camp has been closed since the mid-1970s when the base water system was extended to the area.

Barr et al. (1981) foresee a possible need for the Fort Walton Beach area to develop a supplemental supply of water from the sand and gravel aquifer when pumpage from the Floridan Aquifer exceeds recharge in southern Okaloosa County. If such a supply is ever developed, it could be affected by Phase II study sites, depending on the size and location of the well field.

---

[6]Hartman, R.A. and H.L. Postrozny. 1984. Personal communication. AD/DEV, Eglin AFB, Florida.

3.0 FIELD PROGRAM

3.0 FIELD PROGRAM

3.1 DEVELOPMENT OF FIELD PROGRAM

The Phase II field program was developed from recommendations in the Phase I report, recommendations of the Phase II contractor after review of the Phase I report and a preliminary site visit, and recommendations of OEHL personnel.

The Phase I report contained three levels of recommendations: first priority, second priority, and low priority. Five sites (D-1, D-2, D-26, D-3, and D-41) were classified as first priority sites, and two (D-40 and D-7) were classified as second priority sites. Low priority sites were rated as potential sources of environmental contamination but with a low probability for migration of contaminants beyond the boundaries of Eglin AFB. This Phase II study addresses only the first and second priority sites.

Phase I recommendations for the first and second priority sites were as follows:

1. Installation of one upgradient and three downgradient monitoring wells at each site;
2. Collection of groundwater samples from each well;
3. Analysis of each groundwater sample for chloride, iron, manganese, phenolics, sodium, sulfate, pH, specific conductance, TOX, and total organic carbon (TOC);
4. Collection of leachate samples from Site D-41 and Landfills D-26, D-40, and D-7; and
5. Analysis of leachate samples for chloride, phenolics, iron, manganese, sulfate, pH, specific conductance, TOX, and TOC.

In August 1982, W.D. Adams and J.A. Steinberg of WAR visited Eglin AFB to inspect the study areas, establish liaison with base personnel, and contact potential subcontractors. Following this visit, WAR made several recommendations to OEHL to modify the Phase I report recommendations.

The Phase II study incorporates a number of modifications to the Phase I report recommendations (Table 2). Differences are in the types and numbers of sampling stations and in the recommended analyses. Changes in sampling stations were based on site conditions observed during the preliminary site visit. In every case (except Landfills D-3 and D-7) the scheme of installing one well upgradient and three downgradient of the site was retained. At Landfill D-3, three downgradient wells were installed, and an existing well was used for background water quality. It was not possible to install downgradient wells at Landfill D-7 because this site was created by dumping wastes into a steephead tributary to Tom's Bayou. Consequently, an upgradient well was installed at Landfill D-7, and in lieu of downgradient groundwater samples, three surface water samples were taken adjacent to the fill.

Surface water and bottom sediment sample stations were included for study areas adjacent to streams or ponds. These study areas were Landfills D-1, D-2, D-3, and D-26 and Site D-41. A leachate sampling station was established at one location at Landfill D-1.

Individual sampling stations and/or well sites were chosen in consultation with representatives of several activities at Eglin AFB and Mr. Bill Kellenberger, Chief of Hazardous Waste Section, Northwest District, Florida Department of Environmental Regulation (FDER). Lt. Col. R. Hartman's (Eglin AFB) knowledge of past disposal sites was an invaluable aid in selecting sampling stations.

Analyses to be performed on samples from each site (Table 2) were selected by considering the suspected types of wastes reported for each disposal site in the Phase I report (Table 1).

3.2 IMPLEMENTATION OF FIELD PROGRAM

All monitor wells were installed by a subcontractor (Wright Test Drilling, Inc.) under the supervision of W.D. Adams. Details of monitor well construction and other field methods are contained in Appendix A, and individual well logs are contained in Appendix B. All wells were completed in the sand and gravel aquifer.

The monitor well network was surveyed to determine horizontal coordinates and the elevation of the tops of the well casings by a subcontractor (Gustin, Cothern, Tucker, & Associates).

Single-well aquifer tests were performed at each study site (except Landfill D-7) in April 1983 to obtain representative values of hydraulic conductivity for the uppermost aquifer. A mini-rate pumping test (Strausberg, 1982)[7] was performed in each case except Well D-41C where a falling-head test (Naval Facilities Engineering Command, 1982)[8] was performed because the soil surrounding it had a much lower hydraulic conductivity than the other wells tested. Aquifer test procedures are described in Appendix A.

Sampling was carried out by C.R. Fellows and R.D. Baker at all sample stations in November 1982 and February 1983 (Table 1, Figures 3 and 4). Additional samples were collected for dissolved organic carbon (DOC) and purgeable organics in July 1983. Sampling and preservation procedures are outlined in Appendix A.

3.3 SAMPLE ANALYSIS

Soil and water samples collected at Eglin AFB were analyzed at WAR's Gainesville, Florida laboratory; Harmon Laboratories; Technical Services, Inc. (TSI); and CH_2M Hill. Analytical procedures are described in Appendix C.

While performing TOC and metal analyses on the November 1982 samples, analytical interferences were experienced that caused detection limits to increase (become poorer) and resulted in elevated values for some analytes. Some samples were very turbid, possibly a result of resuspension of settled particulates by the bailer used in sampling. Since the particulate matter producing the turbidity could not have moved any significant distance through this type of sand and gravel aquifer, it was

---

[7]Strausberg, S.I. 1982. Permeability from "mini-rate" pumping tests. Groundwater Monitoring Review. Vol. 2. No 3. pp 23-26.

[8]Naval Facilities Engineering Command. 1982. Soil Mechanics, Design Manual 7.1. Alexandria, Virginia. pp 7.1-103 - 7.1-108.

felt that the turbid samples did not accurately represent the "local" groundwater, and the already acidified metals were filtered in an attempt to correct this. However, this may not have corrected the problem since the acidic samples could have leached or dissolved metals from particulate matter prior to filtration and thus yielded elevated results. During the February 1983 sampling, metal and organic carbon samples were filtered through 0.45-micron membrane filters before acidification in order to produce samples more representative of the "local" groundwater. However, because of this modified sample treatment, the November 1982 and February 1983 data are not directly comparable for metals and organic carbon.

During the February sampling trip, a more extensive effort was made to remove any accumulation of settled particulates from the bottom of the wells before sampling (see Appendix A for details). This reduced the apparent turbidity in the February samples. Reduced turbidity probably accounts for the general decrease in phenolics and oil and grease values of the unfiltered February 1983 samples.

Subsequent to the February 1983 sampling, laboratory equipment malfunctions on instruments for conducting both the organic carbon and purgeable organics analyses resulted in the samples exceeding the U.S. Environmental Protection Agency (EPA) recommended holding times prior to analysis. In the case of the organic carbon samples, it seems unlikely that this would have significantly affected the results since the samples were filtered, acidified, and kept refrigerated. In the case of the purgeable organic samples, it is also unlikely that significant changes would have occurred since the samples were tightly capped and refrigerated. However, the fact remains that the samples did exceed the holding times. After careful review of the situation, it was concluded that additional samples for organic carbon and purgeable organics should be taken to provide further indication of water quality at the various sites. This sampling was carried out in July 1983.

Additional discussion of laboratory analyses is included in Section 4.0.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 DISCUSSION OF RESULTS

4.1.1 Analytical Results

Sample collection and *in situ* measurements were performed in November 1982, February 1983, and July 1983. A sampling and analysis plan for site evaluation is shown in Table 2. The July 1983 sampling was for water samples for purgeable organics and DOC only. The chemical data obtained from these samples are presented in Tables 4 through 19.

State of Florida criteria for the constituents analyzed during this work in both surface water and groundwater are shown in Table 20.

There is no definitive evidence of any immediate threat to human health or the environment at Eglin AFB. However, there is evidence of some contamination downgradient from some of the landfills. This is indicated primarily by increases in specific conductance and, in some instances, by increases in organic carbon or TOX. Low concentrations of DDT were found in a few samples. As is typical of investigations of potential groundwater contamination, the results contain a number of anomalies such as inconsistent patterns of contamination.

Several of the analyses performed on samples collected at Eglin AFB are measures of entire classes or groups of potential contaminants and give no direct indication of the specific compounds involved. Unless these analyses yield exceptionally high values or exceed established regulatory standards, they are best used as indicators of apparent or potential contamination. The nonspecific measures of contamination employed during this study were pH, specific conductance, TOC, DOC, TOX, phenolics, and oil and grease.

A widely used measure of water quality, pH measures the hydrogen ion concentration of a sample and is therefore an indicator of acidity or alkalinity. Values of pH that differ greatly from natural background would indicate strongly acidic or strongly alkaline contaminants had overcome the water's natural buffering capacity. State of Florida standards for pH are 6.5 to 8.5 for Class G-II groundwaters and 6.0 to 8.5 for Class III surface waters, unless natural background varies from these standards. Hayes and Barr (1983) found that pH of groundwater in the sand and gravel aquifer was as low as 4.5. During this study, pH measurements varied from 4.4 to 6.4 with most measurements in the range of 5.0 to 6.0. The pH range of the upgradient wells was 4.4 to 5.8. These data indicate that the pH of all samples was in the natural range, and therefore, do not violate Florida water quality standards for pH.

Specific conductance is a measure of the ability of the sample to conduct an electric current and is consequently a measure of the amount of dissolved ionic materials in the sample. Typically, the major components affecting specific conductance are metallic cations (sodium, iron, calcium, etc.) and inorganic anions (chloride, sulfate, bicarbonate, etc.). Specific conductance may serve as a general indicator of contaminated waters since landfill leachate may become enriched in dissolved salts. The state of Florida has no groundwater criterion for specific conductance; therefore, specific conductance data for groundwater must be interpreted in context of other wells in the area and other data for a given well. Florida surface water criteria provide that "specific conductance shall not be increased more than 100% above background levels or to a maximum of 500 micromhos per centimeter (umhos/cm)..." [Florida Administrative Code (FAC) 17-3.061].

Organic carbon, either dissolved or total, is a measure of the overall level of organic material in a sample. Such organic material may be present as a result of the natural decay of plant materials, or it may represent synthetic organic compounds. Therefore, like specific conductance, organic carbon analyses do not differentiate between naturally occurring organic matter and contamination due to synthetic organic compounds. DOC or TOC must be interpreted in the context of other analyses for the site, analyses from other sample stations, and the environment in which the sample was taken. Florida has no water quality criteria for organic carbon in either groundwater or surface water.

Total organic halides is a measure of organohalides which are organic compounds containing one or more halogens (fluorine, chlorine, bromine, iodine, and astatine). The organohalides constitute a very large class of organic compounds with widespread use in modern society. There were additional tests used at Eglin AFB that measured some, but not all, specific organohalide compounds, namely the organochlorine insecticide, herbicide, PCB, and purgeable organics tests. However, there are many organohalides that would not be detected by these procedures. TOX data are best used as an indicator of whether the compound-specific analyses (e.g., dichloroethylene, DDT, etc.) account for all of the organohalides in the sample.

The test for phenolics used during this study is also a screening test which does not differentiate between synthetic phenolic compounds and naturally occurring phenolic compounds which result from decaying organic matter. Florida has established a surface water criterion (FAC 17-3.061) of 1.0 micrograms per liter (ug/l) for certain phenolic compounds (chlorinated phenols including trichlorophenols; chlorinated creosols; 2-chlorophenol; 2,4-dinitrophenol; and phenol); however, Florida has no groundwater standard for phenolic compounds. The screening test for phenolics will not detect 2,4-dinitrophenol, 2-methyl-4,6-dinitrophenol, or 4-nitrophenol. It may or may not detect 2,4-dimethylphenol. Phenolics data are best evaluated in the context of other data for a site with consideration of the environment from which the sample was collected.

As the name implies, the analysis for oil and grease also measures a variety of compounds as a class without differentiating among them. The Florida surface water criterion (FAC 17-3.061) for dissolved or emulsified oils and greases is a maximum of 5.0 milligrams per liter (mg/l).

4.1.2 Physical Test Results

Elevations of the water table in the monitor wells for November 1982 and February and July 1983 are shown in Figures 5 through 10. As a general rule, elevations of the water table are related directly to the land surface elevations. Hence, near the landfills, groundwater in the sand and gravel aquifer would be expected to flow from the higher points of land toward the closest wetlands and surface water features. Water table elevation data in Figures 5 through 10 confirm the directions of flow assumed above.

The movement of groundwater at each of the sites selected for groundwater monitoring is predominantly horizontal, toward the nearest surface water. Given the water table elevations, hydraulic conductivities, and an assumed porosity of 0.40, groundwater flow velocity may be estimated by an application of Darcy's Law (Freeze and Cherry, 1979)[9] in the form of:

$$q = (K \times I)/p$$

where: q = average linear velocity
K = hydraulic conductivity (M/SEC)
I = hydraulic gradient (dimensionless)
p = porosity (dimensionless).

Once a distance (d) is determined, the time (t) required for groundwater to travel the given distance may be estimated by:

$$t = d/q$$

In the calculations, d was measured for the longest flow path at a site. For example, at Landfill D-1, the longest flow path is from the north end of the landfill to Choctawhatchee Bay.

---

[9] Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, N.J. 604 p.

The hydraulic loading (Q) to a surface water body may be estimated (roughly) as the product of the groundwater velocity (q), the front (f) across which groundwater must move to discharge to surface water, and the thickness of the waste (z) buried below the water table. This last element was derived from the Phase I report.

Table 21 shows the results of these calculations for all sites except Landfill D-7. Well D-7A was too deep to perform the single-well aquifer tests used in this report (Appendix A). The time of travel over the longest path was calculated for Landfill D-2, but the hydraulic loading to surface water could not be estimated. The results in Table 21 are "order-of-magnitude" calculations rather than precise determinations.

4.2 SIGNIFICANCE OF FINDINGS

4.2.1 Eglin Main

4.2.1.1 Landfill D-1, Eglin Main Base Landfill (1940s to early 1960s)--Specific conductance values (Tables 4, 5, and 19) indicate some increase in contaminants in downstream Wells D-1B and D-1C. However, the upgradient well also had specific conductance values well above that found for all other upgradient wells at Eglin AFB (average 194 compared to average 44).

Higher specific conductance values (302 umhos/cm, 135 umhos/cm, and 144 umhos/cm) at the upgradient well are probably related to its proximity to a drainage ditch. Well D-1C is within a few feet of Choctawhatchee Bay which probably accounts for its higher specific conductances (348 umhos/cm, 280 umhos/cm, and 273 umhos/cm). Specific conductance at Well D-1B (191 umhos/cm, 173 umhos/cm, and 155 umhos/cm) may indicate leachate or the effects of storm water runoff flowing into Weekly Pond which is adjacent to Well D-1B.

Organic carbon results showed little, if any, downgradient contamination in February; however, all downgradient wells had higher than background levels in July.

Detectable amounts of TOX were found in all downgradient wells at least once at levels of 0.05 to 0.18 mg/l. The elevated TOX value (0.27 mg/l) in the upgradient well (D-1A) in November 1982 may be due to migration of degreasing solvent from the motor pool area via the drainage ditch to a point adjacent to the well. Consistently elevated TOX values were found only in Well D-1C (0.14 mg/l and 0.18 mg/l).

The 2,740 milligrams per kilogram (mg/kg) (dry weight) of oil and grease found in the downstream sediment (Station D-1F) in February 1983 is inconsistent with the less than detectable value found in November 1982. This inconsistency is probably due to the variable nature and intermittent discharge of this category of compounds. Sources of oil and grease compounds in this ditch include vehicle maintenance, test facilities, and sewage treatment plant effluent.

Low levels of DDT residues were present in both November 1982 (2.4 ug/l) and February 1983 (0.7 ug/l) in Well D-1B, adjacent to Weekly Pond (Tables 4 and 5). Traces of herbicides (<3 ug/l) were found in the three downgradient wells in February 1983 (Table 5).

Data for the leachate samples (Station D-1G) showed consistently high values of specific conductance (335 umhos/cm, 422 umhos/cm, and 369 umhos/cm), oil and grease (10 mg/l and 7 mg/l) and phenolics (7 ug/l and 6 ug/l); however, the leachate did not affect surface water quality at Stations D-1E and D-1F. The portion of Landfill D-1 nearest Station D-1G was used as a storage yard and armored vehicle parking area during sampling.

Phenolics, metals, PCBs and purgeable organics were not found at levels of concern. The elevated concentrations for arsenic, chromium, and lead found in November are believed to be the result of solids collected with these samples (see discussion in Section 3.3 regarding filtered versus unfiltered samples). In the July sampling, chloroform was found at 20 ug/l in the upgradient well. This concentration is well below the drinking water standard of 100 ug/l for total trihalomethanes (Table 20). Trace levels of dichloroethylene and trichloroethylene were found at downgradient Well D-1C in July.

Since Well D-1B showed consistent contamination due to DDT (Table 18), it is probable that DDT has migrated into Weekly Pond. If DDT is present in the sediments of Weekly Pond, bioconcentration of DDT by fish may cause human exposure via consumption of contaminated fish. Bottom feeders, like catfish, are a likely pathway for food chain concentration. Possible human exposure to DDT-contaminated fish is considered the greatest threat posed by Landfill D-1.

Any threat to Choctawhatchee Bay from Landfill D-1 is expected to be small because of the relatively low concentrations of contaminants found in ground and surface waters and the small input to the bay relative to the bay volume (see Table 21).

4.2.1.2 <u>Landfill D-2, Eglin Main Base Landfill Near Commissary (early 1960s to 1972 and 1973)</u>--The specific conductance data (Tables 6, 7, and 19) indicate that dissolved materials have migrated from this landfill to Wells D2-B and D2-C. Almost all constituents that were found at detectable concentrations during the November 1982 sampling were found to be below the detection levels in February 1983. Minimizing suspended material in the samples by pumping prior to sampling is probably responsible for the lower reported values in February.

DOC results were elevated (71 mg/l) at Well D-2B in July. Low levels of DDT and Silvex were found in the retention pond water and sediment samples. These levels were reported for the November 1982 sampling when water had collected in several small depressions in the retention pond bottom. The February samples, taken when water levels were higher, showed no DDT or Silvex contamination. The pond did not appear to be a suitable fish habitat; consequently the low levels of these constituents reported are not believed to pose a threat to human health.

Other analytical results indicated no significant contamination problems.

4.2.1.3 Landfill D-3, Eglin Main Base Landfill Near Cobb's Overrun (1972-1973 to 1978)--High specific conductance values indicate that landfill leachate has migrated to Wells D-3B and D-3D (Tables 8, 9, and 19). High specific conductance in leachate from young landfills is not unexpected. TOX concentrations indicate contaminant migration may have reached downgradient wells and surface waters since organic halogens were detected at all these stations at least once in the November 1982 and February 1983 samplings. The February DOC values indicated no downgradient contamination, but the July results did indicate some contamination.

Contaminant migration to the creek may endanger aquatic organisms or contaminate edible fish species in Jack Lake.

4.2.1.4 Landfill D-7, Receiver Area Disposal Site (1970s)--Specific conductance values (Tables 10, 11, and 19) for surface water at Station D-7B were relatively high for all samplings; this may indicate leachate migration from the landfill into the swamp, but it is not conclusive. Surface water from Station D-7C contained pesticides (DDT) and herbicides (2,4-D and 2,4,5-T). DDT (3 ug/l total DDT-R) and 2,4-D (5 ug/l) were present only in November, but 2,4,5-T (trace to 3 ug/l) was detected both times. Low levels of phenolics (1 to 5 ug/l) were present at Well D-7A and Stations D-7B and D-7C once. The concentrations of phenolics at surface water Stations D-7B (3 ug/l) and D-7C (5 ug/l) in November were higher than the Florida water quality standards (see Section 4.1.1) for specified phenolics; however, in February, phenolics were below detection limits at these stations. Organic carbon and total organic halides results indicated no contamination problems.

4.2.2 Hurlburt Field

4.2.2.1 Landfill D-26, Hurlburt Sanitary Landfill (1972 to 1979)-- Specific conductance and TOX data (Tables 12, 13, and 18) indicate that leachate has migrated to all three downgradient wells. Tests for specific organohalide compounds (organochlorine insecticides; PCBs; 2,4-D; 2,4,5-T; Silvex, and purgeable organics) did not account for the elevated TOX values [0.11 mg chloride per liter (Cl^-/l) to 0.75 mg Cl^-/l in November 1982 and 0.06 mg Cl^-/l to 0.13 mg Cl^-/l in February 1983]. The TOX may be partially accounted for by phenolics at wells D-26B (15 ug/l) and D-26C (7 ug/l) in November and Well D-26B (8 ug/l) in February, but even if the phenolics detected were entirely chlorinated phenolics, they would not completely account for the TOX concentrations. In both November and February, samples from Well D-26D had measureable TOX concentrations (0.75 and 0.16 mg Cl^-/l), but only the February sample contained even a trace of any specific halogenated compounds (2,4-D). DOC values for February and July indicated some downgradient contamination but not at the level indicated by the specific conductance results. Low levels of 2,4-D (8 ug/l) and endrin aldehyde (0.54 ug/l) were found once (November) in Well D-26B and a trace amount of 2,4-D appeared once in Well D-26D. Surface water in the pond at Station D-26E apparently receives some leachate input, but the borrow pit (Station D-26F) appeared to be unaffected by landfill leachate. A seep (Station D-26G), located between wells D-26B and D-26C contained 5 ug/l of phenolics in February. Oil and grease in the sediments at Station D-26E was below the detection limit (<200 mg/kg) in November but was 4,200 mg/kg in February; however, the overlying surface water contained no detectable oil and grease (<5 mg/l) on either occasion.

Because of the land use in the vicinity, contaminants from Landfill D-26 are believed to pose little environmental or human health concerns.

4.2.2.2 Site D-41, Hurlburt Field EOD Site (1950s to 1960s)--The data presented on Tables 14, 15, and 19 indicate that all three downgradient wells are affected by leachate migration. Well D-41D appears to be the most affected while Well D-41B is the least affected. Some variation appears in the downgradient well data between the November and February sampling data. TOX and phenolics concentrations, respectively, decrease or become undetectable. Oil and grease values were undetectable in November but were 6 to 8 mg/l in February. The July specific conductance data indicate that all three downgradient wells are affected whereas the DOC data indicate only Well D-41D is affected.

Surface water data for Site D-41 indicate that surface water draining from this site has little interaction with the subsurface contents of the disposal site.

Since this site contributes only a small hydraulic loading to East Bay Swamp and contaminant concentrations are relatively low, no significant threat to human health or the environment is believed to exist.

4.2.3 Santa Rosa Island

4.2.3.1 Landfill D-40, A-11 Disposal Site (1960s to 1970s)--Specific conductance data of Tables 16, 17, and 19 show a general increase in dissolved solids with decreasing distance between each well and Santa Rosa Sound. Wells D-40C and D-40D are within 100 feet of the shoreline and consistently had the highest specific conductance values. The only contaminants found were TOX and phenolics in low concentrations (i.e., no values were over twice the analytical detection limits).

Since the hydraulic load to the bay is estimated to be small and contaminant concentrations were low, no significant threat to human health or the environment is believed to exist.

5.0 ALTERNATIVE MEASURES

5.0 ALTERNATIVE MEASURES

Three alternatives are possible for the sites investigated:

1. Cleanup or contain the contamination;
2. Conduct further monitoring to determine the need, if any, of cleanup or containment; or
3. Conduct no further monitoring (some nonmonitoring actions may be indicated).

Alternative 1 is appropriate where there is a clear indication that present or future human or environmental problems will exist. The priority for actions would depend on the magnitude of the threat and whether that threat was current or future.

Alternative 2 is appropriate where insufficient evidence exists to place a site in either the Alternative 1 or 3 categories. This alternative should be utilized with care since there is some risk that delay could allow contamination to spread and worsen the problem. The goal should be to gather enough evidence in a timely manner to resolve the question of whether or not the site should be cleaned up. In some cases nonmonitoring actions, generally related to site management options, may be needed.

Alternative 3 is appropriate for sites where there is little, if any, evidence which indicates that the site is or will ever be a source of significant contamination. This decision is difficult to make, since one can never be absolutely sure whether or not a problem will ever exist at a site. However, reasonable judgments must be made so that resources can be allocated to sites that have the highest potential for environmental insult. In some cases nonmonitoring actions, generally related to site management options, may be needed.

For the seven sites studied at Eglin AFB, none are judged to be Alternative 1 sites, four are judged to be Alternative 2 sites, and three are judged to be Alternative 3 sites.

5.1 OPTIONS FOR SITES REQUIRING ADDITIONAL MONITORING

5.1.1 Landfill D-1

Potential contamination of Weekly Pond by DDT is the most immediate human health or environmental concern posed by the data for Landfill D-1. The presence of low levels of DDT in groundwater samples from Well D-1B indicates that DDT may migrate from the groundwater into the sediments and surface water of Weekly Pond. Since Weekly Pond has been used for recreational fishing, it would be appropriate to test fish from Weekly Pond for total DDT residues semiannually. This would involve collecting 10 catfish, filleting them, and preparing two composite samples of five fish each. Analytical results should be compared to the Food and Drug Administration (FDA) action level for fish flesh of 5 parts per million (ppm) total DDT residues (FDA, 1981)[10]. If total DDT residues remained below the FDA action level for two consecutive samplings, there would be no need to continue monitoring DDT in catfish from Weekly Pond. If fish from Weekly Pond exceed the FDA action levels, then Weekly Pond should be closed to recreational fishing.

It should be noted that Weekly Pond is in a limited access area where fishing is controlled by permits issued by the USAF. Fishing in Weekly Pond is presently prohibited due to restocking of the pond (Hartman and Postrozny, 1984).

Other options for future actions at Landfill D-1 are in the category of best management practices for closed landfills. These are discussed in Section 5.3.

5.1.2 Landfill D-3

TOX results were positive at Wells D-3A through D-3C and surface water Station D-3F in November and at Wells D-3B and D-3D and surface water Stations D-3E and D-3F in February. However, no analyses for specific

---

[10]Food and Drug Administration. 1981. Action Level for Poisonous or Deleterious Substances in Human Food and Animal Feed. Washington, D.C. 13 pp.

halogenated organic compounds were performed on samples from Landfill D-3 since the Phase I report (Christopher et al., 1981) found no evidence that such material had been disposed of at this site. The nature of this apparent organohalide contamination could be further investigated by analyzing groundwater and surface water samples from this site for the specific organohalides that have been used at Eglin AFB. These include halogenated solvents (included in purgeable organic analyses); chlorinated insecticides; herbicides (2,4-D, 2,4,5-T, and Silvex); PCBs; and chlorinated phenolics (included in the phenolics screening test). If the results of these analyses indicate organohalide contamination at concentrations that exceed regulatory standards (FAC 17-3 and FAC 17-22), continue monitoring on a semiannual basis. If chlorinated insecticides or PCBs are detected in surface water samples, monitoring should be extended to include edible fish species in Jack Lake. Fishing in Jack Lake is controlled by USAF permit. Analyses of fish flesh should be evaluated by reference to FDA action levels (FDA, 1981).

Other options for future actions at Landfill D-3 are discussed in Section 5.3.

5.1.3 Landfill D-7

Phenolics concentrations in the November samples from surface water Stations D-7B (3 ug/l) and D-7C (5 ug/l) may have exceeded Florida surface water standards (1 ug/l). There is an element of doubt since the Florida standards are for specific phenolic compounds (see Section 4.1), but the screening test for phenolics used in this study does not identify specific phenolic compounds. The November sample from Station D-7C (3 ug/l) also exceeded the Florida surface water standard for DDT (0.001 ug/l). However, samples collected in the winter rainy season (February) contained no detectable DDT or phenolics. Semiannual monitoring of surface water and sediments for DDT and phenolics would determine if the results of this study detected a seasonal variation. The pond at the base of Landfill D-7 is in an area that is closed to fishing; however, if DDT is again detected in the surface water, monitoring of DDT should be expanded to include catfish. If total DDT residues in catfish fillets should exceed the FDA action level of 5 ppm (FDA, 1981), the unnamed pond at the base of Landfill D-7 should remain closed to recreational fishing.

Low concentrations (trace to 3 ug/l) of 2,4,5-T were present in samples from surface water Station D-7C in both November and February and at Station D-7B in February, and are probably indicative of the widespread use of this herbicide. The presence of 2,4,5-T indicates that 2,3,7,8-TCDD may also be present since 2,3,7,8-TCDD is a contaminant produced during one of two processes used to produce 2,4,5-T (Harrison et al., 1979 and Young et al., 1978). Young et al. (1978) reported that the weighted mean concentration of 2,3,7,8-TCDD in a 50:50 mixture of 2,4,5-T and 2,4-D (a widely used herbicide formulation) was 1.98 ppm; the range of 2,3,7,8-TCDD in the mixture varied from 0.02 ppm to 47 ppm. Given the above weighted mean concentration of 2,3,7,8-TCDD in a mixture containing 50 percent 2,4,5-T, one may expect the mean ratio of 2,3,7,8-TCDD to 2,4,5-T to be approximately 4 ppm.

If this relation were valid for surface waters in the vicinity of Station D-7C, the maximum probable concentration of 2,3,7,8-TCDD associated with the February sample (3 ug/l 2,4,5-T) would be approximately 1.2 x 10^{-5} ug/l. If the non-quantifiable trace of 2,4,5-T detected in November were assumed to be approximately 1 ug/l, the concentration of 2,3,7,8-TCDD would be approximately 4 x 10^{-6} ug/l.

EPA (1984) has recently issued water quality criteria for 2,3,7,8-TCDD which are a "non-regulatory, scientific assessment of its ecological effects." Human health criteria for 2,3,7,8-TCDD were based upon a non-threshold assumption for adverse health effects and represent concentrations estimated to cause a specified level of incremental cancer risk. The criteria are based on an assumption that lifetime intake of the pollutant comes from two sources: (1) drinking an average of 2 liters of water per day, and (2) ingesting an average of 6.5 grams of fish per day. The human health criterion for 2,3,7,8-TCDD which EPA has estimated will cause lifetime incremental cancer risk of 10^{-6} (one case in a million) from the consumption of water only is 2.2×10^{-7} ug/l; the criterion for consumption of aquatic organisms only at the same risk level is 1.4×10^{-8} ug/l. Since these concentrations are one to three orders of magnitude lower than the potential concentrations of 2,3,7,8-TCDD calculated above, there is a potential that the criteria may be exceeded in the surface waters at the base of Landfill D-7.

A conservative approach to environmental health issues suggests that a second option for additional monitoring at Landfill D-7 would be to analyze samples of surface water and sediment from Stations D-7b through D-7d for 2,3,7,8-TCDD on two occasions separated by 6 months. The present analytical detection limit for 2,3,7,8-TCDD is approximately 5×10^{-5} ug/l (EPA, 1984). Since this detection limit is above the EPA water quality criteria for human health and is close to the higher potential concentration calculated for surface waters adjacent to Landfill D-7, analyses for 2,3,7,8-TCDD should be supplemented by analyses for 2,4,5,-T at a lower detection limit. Analyses for 2,4,5,-T in this study were performed by high performance liquid chromatography (HPLC) with a detection limit of 5 ug/l. A lower detection limit (6×10^{-2} u/gl) may be attained by using gas chromatographic (GC) techniques at an increased cost over HPLC. By using analysis for 2,4,5,-T at a detection limit of 6×10^{-2} ug/l and assuming a mean contamination level of 2,3,7,8-TCDD of 4 ppm in 2,4,5-T one could, in effect, extend the detection limit for 2,3,7,8-TCDD to about 2.4×10^{-7} ug/l which is essentially the EPA water quality criterion concentration for a 10^{-6} cancer risk based on direct ingestion of water. The use of 2,4,5,-T as a surrogate for 2,3,7,8-TCDD may be the only technically available scheme to estimate the potential concentration of 2,3,7,8-TCDD at the extremely low levels cited in the EPA water quality criteria.

Additional options for future work at Landfill D-7 fall into the category of best management practices which are discussed in Section 5.3.

5.1.4 Landfill D-26

In both November and February samplings, TOX results were positive in all three downgradient wells; however, in no instance did the sum of the specific halogenated organics analyses (organochlorine insecticides, PCBs, herbicides, purgeable organics, and phenolics) equal the concentration of TOX. This implies that other organohalides are responsible for TOX detected at this site. A reasonable next step in trying to identify organohalide contamination at this site would be to analyze groundwater samples from Landfill D-26 for organohalides in the base/neutral extractable organics section of the priority pollutant list (Table 22). If the results of the "base/neutral" analyses do not satisfy the TOX mass balance equation, then either the TOX results represent a high degree of contamination from rare organohalides or the TOX analysis is an unreliable indicator of organohalide contamination of environmental samples.

A second option for continued monitoring at Landfill D-26 would be analysis of groundwater from Well D-26A, the upgradient well for 2,3,7,8-TCDD and 2,4,5-T at the above-mentioned detection limits. This is based upon the presence of 2,4,5-T in both samples collected from this well. By following the logic developed in the preceding section, potential concentration of 2,3,7,8-TCDD may be calculated as 2.4×10^{-5} ug/l and 4×10^{-6} ug/l based on 2,4,5-T concentrations of 6 ug/l and a trace, respectively. These potential concentrations are higher than the EPA criterion (2.2×10^{-7} ug/l) for consumption of water.

It should be recognized that organic matter in soils tends to adsorb both 2,4,5-T and 2,3,7,8-TCDD (Harrison _et al._, 1979; EPA, 1984; Young _et al._, 1979). Apparently because of this, the EPA water quality criteria document (EPA, 1984) states that leaching of 2,3,7,8-TCDD into groundwater appears unlikely; however, the document cited no substantiating data. During this study, a search of 27 scientific and technical data bases yielded no citations in which the potential presence of 2,3,7,8-TCDD in groundwater was investigated.

In addition to continued monitoring, other options for future action at Landfill D-26 are discussed in Section 5.3.

5.2 OPTIONS FOR SITES NOT REQUIRING ADDITIONAL MONITORING

5.2.1 Landfill D-2

Analytical results in this study did not indicate levels of contamination that would require continued monitoring. Future actions, other than monitoring, are discussed in Section 5.3

5.2.2 EOD Training Range (Site D-41)

Although TOX was detected consistently in wells D-41C and D-41D, it is unlikely that this site represents a significant environmental hazard. No purgeable organic compounds were detected, and phenolics were detected in November but not February in downgradient wells D-41C and D-41D. The use of Site D-41 as an EOD training range makes other organohalides improbable candidates for analysis. Therefore, there is no clear reason to continue monitoring Site D-41.

Section 5.3 discusses future nonmonitoring options for this site.

5.2.3 Landfill D-40

The data give no consistent indication of contamination at this site. Although TOX was detected in groundwater from all wells in February, these values were at or slightly above the detection limit. TOX data in the earlier set of samples were either at or below the detection limit. Waste solvents were the only organohalides reportedly disposed of at this site (Christopher et al., 1981); however, the purgeable organics scan data were all below the detection limit. Consequently, there is no clear reason to continue monitoring of this site.

Other options for future actions at this site are discussed in Section 5.3.

5.3 MANAGEMENT PRACTICES

The state of Florida has published closure and maintenance requirements for all land disposal sites in FAC 17-7.07. These requirements are:

"(1) Access to the site shall be restricted by an effective barrier designed to prevent unauthorized entry into the landfill site.

(2) Information signs shall be placed at the entrance to the site and on roads leading to the site stating that it is closed, the penalty for dumping at the site, the location and hours of operation of the alternate approved site and the name of the operating agency.

(3) A responsible person shall be assigned to supervise the closing procedures on a full time basis during the closing operations.

(4) Two (2) feet of final cover material is required before final closing of the site. The cover material shall be compacted in six (6) inch layers with the final six (6) inches loosely compacted to promote plant growth. The sides of all completed landfills shall have a slope not steeper than one (1) foot vertical to three (3) feet horizontal to minimize erosion. (5) Upon completion, the closed site shall be seeded or planted with grass or suitable cover vegetation.

(6) Upon completion, the closed site shall be properly maintained. This includes erosion control, maintenance of grass cover, prevention of ponding and prevention of deposited waste from becoming a hazard or nuisance until the site is stabilized.

(7) Continued monitoring of the potential polluting sites is required. This will include collection and treatment of leachates until the site is stabilized.

(8) Upon completion the closed site must be publicly recorded in the county property recording office.

(9) The requirements in Section 17-7.07(1), (2), (3), (4), (5), and (8) shall be completed within one year of the closing of the site to incoming waste."

Since all of the Phase IIb study sites at Eglin AFB have been closed to incoming wastes since the dates indicated in Table 1, the provisions of FAC 17-7.07 may not legally apply to those sites, but these regulations indicate the "current" best management practices applicable to closed land disposal sites in the state of Florida. Items (1) through (5) pertain to the actual process of closing a land disposal site. Item (6) describes required maintenance actions, and Item (7) describes the requirement for continued monitoring of potential polluting sites. The need for continued monitoring for the present study is addressed in Sections 5.1 and 5.2. As an adjunct to Item (8), it would be appropriate for Eglin AFB to note the location of its former land disposal sites on the base master plan.

Well field development considerations are not included in FAC 17-7.07; however, the USAF and local government should consider all landfills as limiting factors in selecting locations of future well fields, particularly those which draw water from the sand and gravel aquifer. Although there are no present large-scale withdrawals from the sand and gravel aquifer in the study area, Barr _et al_. (1981) foresee a possible need for the Fort Walton Beach area to develop a supplemental supply of water from the sand and gravel aquifer when pumpage from the Floridan Aquifer exceeds recharge in southern Okaloosa County.

6.0 RECOMMENDATIONS

6.0 RECOMMENDATIONS

The best management practices described in Section 5.5 apply to all of the Phase IIb study sites. WAR recommends that Eglin AFB follow the best management practices of FAC 17-7.07. Certain sites will require corrective measures to meet the standards in FAC 17-7.07; these measures are discussed in the following sections.

6.1 EGLIN MAIN

6.1.1 Landfill D-1

1. Sample catfish from Weekly Pond on a semiannual basis as described in Section 5.1.1, and analyze composited fillets for total DDT residues. If total DDT residues exceed the FDA action level of 5 ppm, close Weekly Pond to recreational fishing. If total DDT residues are less than 5 ppm for two semiannual analyses, discontinue sampling.

6.1.2 Landfill D-2

1. Data for this site do not indicate that it poses a threat to human health or the environment; therefore, no further monitoring is required.

6.1.3 Landfill D-3

1. Investigate the nature of apparent organohalide contamination at this site by analyzing samples of groundwater and surface water on a semiannual basis for volatile organic halocarbons, chlorinated insecticides, herbicides, PCBs, and chlorinated phenolics. If regulatory standards (FAC 17-3 and FAC 17-22) for specific organohalides are exceeded, continue monitoring on a semiannual basis. If chlorinated insecticides or PCBs are detected in surface water samples, analyze fish flesh from Jack Lake for these compounds and compare analytical results to FDA action levels (FDA, 1981).

2. Remove and properly dispose of the small quantity of material that has been dumped at this site since closure. Post signs prohibiting future dumping at the site as described in FAC 17-7.07(2) (Section 5.3).

6.1.4 Landfill D-7

1. Conduct semiannual monitoring of surface waters and sediments for DDT and phenolics. If DDT is present, analyze samples of catfish flesh for DDT. If catfish from the unnamed pond at the base of Landfill D-7 exceed the FDA action level for DDT, close the pond to fishing.
2. Conduct semiannual monitoring of surface waters and sediments for 2,3,7,8-TCDD and 2,4,5-T as discussed in Section 5.1.3. If results of two sets of analyses are negative, discontinue sampling.
3. Improve maintenance of Landfill D-7 by controlling erosion of the landfill margin and mowing the vegetation to halt the old-field succession presently in progress. Erosion control may require preliminary engineering analysis since the landfill margin is a cliff approximately 60 feet high.

6.2 HURLBURT FIELD

6.2.1 Landfill D-26

1. Sample all downgradient wells and analyze for organohalides in the base/neutral extractable organics section of the priority pollutant list plus TOX on a semiannual basis. If results of two sets of analyses are negative, discontinue sampling.
2. Analyze samples from the upgradient well for 2,3,7,8-TCDD and 2,4,5-T on a semiannual basis. If results of two sets of analyses are negative, discontinue sampling.
3. Remove and properly dispose of the small quantity of material that has been dumped at this site since closure. Post signs prohibiting future dumping at the site as described in FAC 17-7.07(2) (Section 5.3).
4. Take steps to control erosion at the downgradient margin of Landfill D-26. Maintain the vegetative cover by mowing to halt the old-field succession in progress.

6.2.2 EOD Training Range (Site D-41)

1. Data for Site D-41 do not indicate that this site poses a significant threat to human health or the environment; therefore, no further monitoring is recommended.
2. The cover at this site is considered inadequate since chunks of napalm are evident on the land surface. Install an additional 2 feet of cover material and establish a suitable vegetative cover material as described in FAC 17-7.07(4) and (5) (Section 5.3).

6.3 SANTA ROSA ISLAND

6.3.1 Landfill D-40

1. Data for this site do not indicate that it poses a significant threat to human health or the environment; therefore, no further monitoring is recommended.

6.4 ALL SITES

Any future siting of potable water wells in the area should be done with full knowledge and consideration of the potential hazard that any abandoned landfill poses to such installations.

7.0 TABLES

Table 1. Phase II-Field Evaluation Study Sites at Eglin AFB

Site	Site Name	Period of Operation	Area Size (Acres)	Suspected Types of Wastes	Estimated Quantity of Waste (Acre-Ft)
EGLIN MAIN					
D1	Eglin Main Base Landfill	1940's-early 60's	100	Construction rubble, tires, wires, hydraulic fuels, waste oils, waste solvents, septic tank sludges, general refuse, sanitary wastes, PCB capacitors, pesticide containers and pesticides	1,000
D2	Eglin Main Base Landfill Near Commissary	Early 60's-72/73	50	Construction rubble, tires, wood, hydraulic fuels, septic tank sludges, garbage, hardfill, waste solvents, general refuse, PCB capacitors, waste fuel oil, pesticide containers, pesticides, metal plating sludges	200-350
D3	Eglin Main Base Landfill Near Cobbs Overrun	1972/73-1978	30-35	Hardfill (tires, wire, spools, mattresses, concrete), general refuse, septic tank sludges, oil/water separator sludges.	100-150
D7	Receiver Area Disposal Site	1970's	10	Hardfill (tires, wire, spools, mattresses, concrete), asbestos insulation, PCB capacitors, PCB transformers, electrical components, paint shop wastes, aqueous film-forming foams (AFFF), waste fuel oils, solvents, septic tank pumpings, Federal Prison garbage, waste pesticides and containers	80
HURLBURT FIELD					
D26	Sanitary Landfill	1972-1979	5	Rubbish, trash, tires, boards, old building materials, concrete, asphalt, empty drums, waste treatment plant sludge, solvent degreasers, waste oils, pesticide containers, PCB capacitors	25-30
D41	EOD Training Range	1950's-1960's	1-2	Napalm, bomb fuzes, small arms ammunition, bulk explosives	
SANTA ROSA ISLAND					
D40	A-11 Disposal Site	1960's-1970's	0.5	Hardfill, metal spools, drums of waste oil, solvent drums with solvent	6-7

Source: Christopher et al., 1981.

Table 2. Schedule of Samples for Eglin AFB, November 1982 and February 1983

Station	GWCI*	Metals†	Phenolics	Oil & Grease	Organo-chlorine Pesticides/ PCBs	Herbicides**	Purgeable Organics
D-1A	G	G	G	G	G	G	G
D-1B	G	G	G	G	G	G	G
D-1C	G	G	G	G	G	G	G
D-1D	G	G	G	G	G	G	G
D-1G	L	L	L	L	L	L	L
D-1E	S	S	S	S,Sd	S,Sd	S,Sd	S
D-1F	S	S	S	S,Sd	S,Sd	S,Sd	S
D-2A	G	G	G	G	G	G	G
D-2B	G	G	G	G	G		G
D-2C	G	G	G	G	G		G
D-2D	G	G	G	G	G		G
D-2E	S	S	S	S,Sd	S,Sd	Sd	S
D-3A	G			G			
D-3B	G			G			
D-3C	G			G			
D-3D	G			G			
D-3E	S			S,Sd			
D-3F	S			S,Sd			
D-7A	G		G	G	G	G	G
D-7B	S		S	S	S	S	S
D-7C	S		S	S	S	S	S
D-7D	S		S	S	S	S	S
D-3B	S		S	S	S	S	S
D-3C	S		S	S	S	S	S
D-3D	S		S	S	S	S	S
D-26A	G		G	G	G	G	G
D-26B	G		G	G	G	G	G
D-26C	G		G	G	G	G	G
D-26D	G		G	G	G	G	G
D-26E	S		S	S,Sd	S,Sd	S,Sd	S
D-40A	G		G	G			G
D-40B	G		G	G			G
D-40C	G		G	G			G
D-40D	G		G	G			G
D-41A	G		G	G			G
D-41B	G		G	G			G
D-41C	G		G	G			G
D-41D	G		G	G			G
D-41E	S, Sd		S,Sd	S,Sd			S,Sd

*GWCI = pH, specific conductance, TOC, and TOX.
†Metals = As, Cd, Cr, Co, Pb, Hg, Ni, Ag, Zn.
**Herbicides = 2,4-D; 2,4,5-T; Silvex.
G = groundwater sample.
L = leachate sample.
S = surface water sample.
Sd = sediment sample.

Table 3. Geologic Units in the Vicinity of Eglin AFB, Florida and their Hydrogeologic Equivalents (Page 1 of 2)

Epoch	Stage	Formation	Thickness (ft)	Lithologic Description	Hydrogeologic Unit	Hydrologic Characteristics
Recent to Pliocene		Pliocene and Recent Sands	0 to 250	Unconsolidated, white to light gray, fine to medium quartz sand. Accessories include heavy minerals and phosphate.	Sand and Gravel Aquifer	Water mainly unconfined. In Fort Walton Beach, includes surficial unconfined unit and lower leaky artesian unit. Yields range from less than 20 gal/min in coastal lowlands of Walton County to 1,000 gal/min in uplands of western Okaloosa County. Tapped by shallow wells for domestic supply and a few larger-capacity wells for irrigation. Currently not used by municipal systems for public consumption.
		Citronelle Formation	0 to 250	Predominantly nonmarine quartz sands with thin stringers of clay or gravel, discontinuous over short distances.		
Miocene		Miocene Coarse Clastics	0 to 250	Found only along the western portion of Okaloosa County, the Miocene coarse clastics are comprised of poorly consolidated sand, gravel, clay, and shell beds.		
Upper Miocene	Choctaw-whatchee	Intracoastal	0 to 250	Lithologically, the Intracoastal is made up of a poorly consolidated, sandy, clayey, microfossiliferous limestone.	Pensacola Clay Confining Bed	Restricts vertical movement of water because of thickness and comparatively low permeability. In the area of investigation grades laterally from dense clay and sandy clay in western part to clayey, silty sand in the eastern part. Not a source of water.
Upper to Middle Miocene	Alum Bluff	Alum Bluff Group	0 to 300	The Alum Bluff occurs as a mixture of sands, clays, and shell beds in relatively well-sorted, thin beds. The matrix material is commonly clay or carbonate cement.		
		Pensacola Clay	0 to 190	In the western half of the study area, the Pensacola Clay interfingers with the Intracoastal Formation and Alum Bluff Group. The Pensacola is predominantly a bluish gray to olive gray, dense, silty clay.		

Table 3. Geologic Units in the Vicinity of Eglin AFB, Florida and Their Hydrogeologic Equivalents (Page 2 of 2)

Epoch	Stage	Formation	Thickness (ft)	Lithologic Description	Hydrogeologic Unit	Hydrologic Characteristics
Lower Miocene	Tampa	Bruce Creek Limestone	20 to 220	Light gray to white in appearance, the Bruce Creek is moderately indurated, granular, and occurs as a clastic limestone. Accessories include a sand fraction which increases north and east.	Upper Limestone of the Floridan Aquifer	Principal source of water in Okaloosa and Walton Counties. Yields large quantities of fresh water under confined conditions. Yields range from 250 gal/min to over 1,000 gal/min. Sustained yields are generally lowest immediately adjacent to the coast in Okaloosa County. Individual zones vary greatly in permeability and vertical hydraulic connection. Contains over 250 ppm chlorides in parts of southeastern Walton and southwestern Okaloosa Counties.
		Tampa Stage Limestones	30 to 140	Lithologically, similar to Chickasawhay Limestones but slightly less dolomitic. Silt and clay content increase towards to top of the formation.		
Upper Oligocene	Vicksburg	Chickasawhay	30 to 260	Primarily a tan sucrosic dolomite but may also occur as a cream to buff fossiliferous limestone.		
Middle to Lower Oligocene		Bucatunna Clay ~~Member~~ of Byram Formation	0 to 130	The Bucatunna is a medium brown to dusky, yellowish-brown calcareous clay. Accessories include up to 10% quartz sand and up to 1% phosphate. The top contact of the Bucatunna Clay is sharp and well defined from the overlying limestone.	Bucatunna Clay Confining Bed	Where present, restricts vertical movement of water between overlying and underlying hydrogeologic units. Generally present in coastal Walton and Okaloosa counties but absent in northern parts of area.
Upper Eocene	Jackson	Ocala Group Limestones	165 to 600	A white to light gray, chalky, fossiliferous, relatively pure calcium carbonate limestone. Occasionally, the limestone is interlayered with thin streaks of light brown to tan dolomite.	Lower Limestone of the Floridan Aquifer	Comprises a separate hydrogeologic unit in coastal Walton and Okaloosa Counties. In other parts, cannot be hydrologically distinguished from upper limestone aquifer (rocks of Lower Miocene and Upper Oligocene Age).

Source: Modified from Barr et al., 1981.

Table 4. Results of Analyses of Samples Collected in the Vicinity of Landfill D-1, November 1982

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Leachate G	Sediment E	Sediment F
pH	5.8	5.9	5.5	5.5	6.3	6.2	5.9	NA	NA
Specific conductance (umhos/cm)	302	191	348	59	137	125	335	NA	NA
TOC (mg/l)	88	344	89	235	<1	2	17	NA	NA
TOX (mg Cl^-/l)	0.27	0.11	0.14	<0.05	<0.05	<0.05	0.08	NA	NA
Oil and grease (mg/l)	6	<5	18	<5	<5	<5	10	<200†	<200†
Phenolics (ug/l)	56	<1	12	5	<1	<1	7	NA	NA
Arsenic (ug/l)	18	317	45	153	<10	<10	<10	NA	NA
Cadmium (ug/l)	<1	1	2	2	7	<1	1	NA	NA
Chromium (ug/l)	<10	93	40	94	<10	<10	<10	NA	NA
Cobalt (ug/l)	<10	19	14	29	<10	<10	<10	NA	NA
Lead (ug/l)	34	82	<25	57	<25	<25	<25	NA	NA
Mercury (ug/l)	<2	<2	<2	<2	<2	<2	<2	NA	NA
Nickel (ug/l)	<10	27	<10	45	<10	<10	<10	NA	NA
Silver (ug/l)	<1	<1	<1	<1	<1	<1	<1	NA	NA
Zinc (mg/l)	0.02	0.06	0.05	0.05	0.04	0.03	0.04	NA	NA
Organochlorine pesticides (ug/l)	ND	DDT*	ND	ND	ND	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	<3	<3	<3	<3	<3	ND	ND
2,4,5-T (ug/l)	<3	<3	<3	<3	<3	<3	<3	ND	ND
Silvex (ug/l)	<3	<3	<3	<3	<3	<3	<3	ND	ND
Purgeable organics (ug/l)	<10	<10	<10	<10	<10	<10	<10	NA	NA

NOTES: NA = not analyzed.
ND = none detected.

*See Table 18 for specific parameters and concentrations found.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 5. Results of Analyses of Samples Collected in the Vicinity of Landfill D-1, February 1983

Parameter	Groundwater				Surface Water		Leachate	Sediment	
	A	B	C	D	E	F	G	E	F
pH	4.6	5.8	5.5	5.5	5.2	5.9	6.0	NA	NA
Specific conductance (umhos/cm)	135	173	280	61	135	135	422	NA	NA
DOC (mg/l)*	22	22	22	16	25	9	27	NA	NA
TOX (mg Cl^-/l)	0.05	0.05	0.18	0.05	<0.05	<0.05	<0.05	NA	NA
Oil and grease (mg/l)	5	<5	<5	<5	<5	<5	7	490†	2740†
Phenolics (ug/l)	<1	<1	4	<1	<1	<1	6	NA	NA
Arsenic (ug/l)	<2	<2	<2	<2	<2	<2	<2	NA	NA
Cadmium (ug/l)	0.9	<0.2	<0.2	0.3	1.0	0.2	<0.2	NA	NA
Chromium (ug/l)	<2	<2	<2	<2	<2	<2	<2	NA	NA
Cobalt (ug/l)	<5	<5	<5	<5	<5	<5	<5	NA	NA
Lead (ug/l)	<5	<5	<5	<5	8	<5	<5	NA	NA
Mercury (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA	NA
Nickel (ug/l)	<2	<2	<2	<2	<2	<2	<2	NA	NA
Silver (ug/l)	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA
Zinc (mg/l)	0.02	0.02	0.02	0.01	0.02	0.02	0.02	NA	NA
Organochlorine pesticides (ug/l)	ND	DDT**	ND	ND	ND	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	Trace	Trace	<3	<3	<3	<3	ND	ND
2,4,5-T (ug/l)	<3	<3	<3	<3	<3	<3	<3	ND	ND
Silvex (ug/l)	<3	<3	<3	Trace	<3	<3	<3	ND	ND
Purgeable organics* (ug/l)	<10	<10	<10	<10	<10	<10	<10	NA	NA

NOTES: NA = not analyzed.
ND = none detected.
Trace = peak detected, but less than stated detection limit.
All metals values for February sampling trip are for the dissolved (<0.45 um) fraction.

*Holding time was exceeded.
**See Table 18 for specific parameters and concentrations found.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 6. Results of Analyses of Samples Collected in the Vicinity of Landfill D-2, November 1982

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Sediment E
pH	4.9	5.4	6.0	5.7	5.8	NA
Specific conductance (umhos/cm)	27	168	137	31	53	NA
TOC (mg/l)	151	179	31	19	18	NA
TOX (mg Cl^-/l)	<0.05	<0.05	0.06	0.09	<0.05	NA
Oil and grease (mg/l)	<5	<5	<5	<5	8	<200†
Phenolics (ug/l)	<1	4	<1	<1	11	NA
Arsenic (ug/l)	111	225	<10	<10	<10	NA
Cadmium (ug/l)	2	1	2	1	16	NA
Chromium (ug/l)	64	90	29	<10	<10	NA
Cobalt (ug/l)	25	60	<10	<10	<10	NA
Lead (ug/l)	<25	25	<25	<25	42	NA
Mercury (ug/l)	<2	<2	<2	<2	<2	NA
Nickel (ug/l)	55	71	28	<10	33	NA
Silver (ug/l)	<1	<1	<1	<1	<1	NA
Zinc (mg/l)	0.08	0.08	0.05	0.03	0.10	NA
Organochlorine pesticides (ug/l)	ND	ND	ND	ND	DDT*	DDT*
PCBs (ug/l)	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	<3	<3	<3	ND
2,4,5-T (ug/l)	<3	<3	<3	<3	<3	ND
Silvex (ug/l)	<3	<3	<3	<3	Trace	ND
Purgeable organics (ug/l)	<10	<10	<10	<10	<10	NA

NOTES: NA = not analyzed.
ND = none detected.
Trace = peak detected, but less than stated detection limit.

*See Table 18 for specific parameters and concentrations found.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 7. Results of Analyses of Samples Collected in the Vicinity of Landfill D-2, February 1983

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Sediment E
pH	5.3	5.3	5.5	5.5	5.8	NA
Specific conductance (umhos/cm)	35	105	139	27	48	NA
DOC (mg/l)*	12	12	15	15	17	NA
TOX (mg Cl^-/l)	<0.05	<0.05	<0.05	<0.05	<0.05	NA
Oil and grease (mg/l)	<5	<5	<5	<5	<5	<200†
Phenolics (ug/l)	<1	<1	<1	2	1	NA
Arsenic (ug/l)	<2	<2	<2	<2	<2	NA
Cadmium (ug/l)	<0.2	0.5	<0.2	0.4	0.6	NA
Chromium (ug/l)	<2	<2	<2	<2	<2	NA
Cobalt (ug/l)	<5	<5	<5	<5	<5	NA
Lead (ug/l)	<5	<5	<5	<5	<5	NA
Mercury (ug/l)	<0.2	0.3	<0.2	<0.2	<0.2	NA
Nickel (ug/l)	<2	<2	<2	<2	<2	NA
Silver (ug/l)	2.5	<0.5	0.6	<0.5	<0.5	NA
Zinc (mg/l)	<0.01	<0.01	0.02	<0.01	0.02	NA
Organochlorine pesticides (ug/l)	ND	ND	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	<3	<3	<3	ND
2,4,5-T (ug/l)	<3	<3	<3	<3	<3	ND
Silvex (ug/l)	<3	<3	<3	<3	<3	ND
Purgeable organics* (ug/l)	<10	<10	<10	<10	<10	NA

NOTES: NA = not analyzed.
DOC = dissolved total organic carbon.
ND = none detected.
All metals values for February sampling trip are for the dissolved (<0.45 um) fraction.

*Holding time was exceeded.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 8. Results of Analyses of Samples Collected in the Vicinity of Landfill D-3, November 1982

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Sediment E	Sediment F
pH	4.6	5.6	5.6	5.6	5.5	6.0	NA	NA
Specific conductance (umhos/cm)	63	1,144	35	702	115	284	NA	NA
TOC (mg/l)	14	157	302	658	5	19	NA	NA
TOX (mg Cl^-/l)	0.05	0.21	0.27	<0.05	<0.05	0.13	NA	NA
Oil and grease (mg/l)	8	<5	<5	<5	<5	<5	320*	<200*

NOTES: NA = not analyzed.

*Oil and grease values for sediments are in mg/kg dry weight.

Table 9. Results of Analyses of Samples Collected in the Vicinity of Landfill D-3, February 1983

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Sediment E	Sediment F
pH	5.5	5.8	5.5	5.8	5.5	5.8	NA	NA
Specific conductance (umhos/cm)	61	797	23	718	168	303	NA	NA
DOC (mg/l)*	12	21	20	19	18	15	NA	NA
TOX (mg Cl^-/l)	<0.05	0.13	<0.05	0.15	0.05	0.08	NA	NA
Oil and grease (mg/l)	<5	<5	<5	7	<5	<5	<200†	<200†

NOTES: NA = not analyzed.

*Holding time was exceeded.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 10. Results of Analyses of Samples Collected in the Vicinity of Landfill D-7, November 1982

Parameter	Groundwater A	Surface Water B	Surface Water C	Surface Water D
pH	5.7	6.1	6.4	6.4
Specific conductance (umhos/cm)	34	330	56	84
TOC (mg/l)	86	8	7	6
TOX (mg Cl^-/l)	<0.05	<0.05	<0.05	<0.05
Oil and grease (mg/l)	<5	<5	<5	<5
Phenolics (ug/l)	<1	3	5	<1
Organochlorine pesticides (ug/l)	ND	ND	DDT*	ND
PCBs (ug/l)	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	5	<3
2,4,5-T (ug/l)	<3	<3	Trace	<3
Silvex (ug/l)	<3	<3	<3	<3
Purgeable organics (ug/l)	<10	<10	<10	<10

NOTES: ND = none detected.
Trace = peak detected, but less than stated detection limit.

*See Table 18 for specific parameters and concentrations found.

Table 11. Results of Analyses of Samples Collected in the Vicinity of Landfill D-7, February 1983

Parameter	Groundwater	Surface Water		
	A	B	C	D
pH	5.3	5.5	5.3	5.3
Specific conductance (umhos/cm)	32	386	66	64
DOC (mg/l)*	12	23	14	14
TOX (mg Cl^-/l)	<0.05	0.05	<0.05	<0.05
Oil and grease (mg/l)	<5	<5	<5	<5
Phenolics (ug/l)	1	<1	<1	<1
Organochlorine pesticides (ug/l)	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	<3	<3
2,4,5-T (ug/l)	<3	Trace	3	<3
Silvex (ug/l)	<3	<3	<3	<3
Purgeable organics* (ug/l)	<10	<10	<10	<10

NOTES: ND = none detected.
Trace = peak detected, but less than stated detection limit.

*Holding time was exceeded.

Table 12. Results of Analyses of Samples Collected in the Vicinity of Landfill D-26, November 1982

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Sediment E
pH	5.6	5.8	5.8	5.7	5.8	6.5	NA
Specific conductance (umhos/cm)	33	864	325	115	151	64	NA
TOC (mg/l)	340	79	81	5,660	2	5	NA
TOX (mg Cl^-/l)	<0.05	0.11	0.13	0.75	<0.05	<0.05	NA
Oil and grease (mg/l)	<5	<5	<5	<5	<5	<5	<200†
Phenolics (ug/l)	<1	15	7	<1	2	<1	NA
Organochlorine pesticides (ug/l)	ND	EA*	ND	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	8	<3	<3	<3	<3	ND
2,4,5-T (ug/l)	6	<3	<3	<3	<3	<3	ND
Silvex (ug/l)	<3	<3	<3	<3	<3	<3	ND
Purgeable organics (ug/l)	<10	<10	<10	<10	<10	<10	NA

NOTES: NA = not analyzed.
ND = none detected.
EA = endrin aldehyde.

*See Table 18 for specific parameters and concentrations found.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 13. Results of Analyses of Samples Collected in the Vicinity of Landfill D-26, February 1983

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Surface Water G	Sediment E
pH	5.0	5.5	5.5	5.0	5.5	5.5	NA	NA
Specific conductance (umhos/cm)	28	680	238	41	183	44	NA	NA
DOC (mg/l)*	11	22	21	16	17	17	26	NA
TOX (mg Cl^-/l)	<0.05	0.13	0.06	0.16	0.06	<0.05	NA	NA
Oil and grease (mg/l)	<5	<5	<5	<5	<5	<5	<5	4,200†
Phenolics (ug/l)	<1	8	<1	<1	<1	<1	5	NA
Organochlorine pesticides (ug/l)	ND	ND	ND	ND	ND	ND	ND	ND
PCBs (ug/l)	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D (ug/l)	<3	<3	<3	Trace	<3	<3	<3	ND
2,4,5-T (ug/l)	Trace	<3	<3	<3	<3	<3	<3	ND
Silvex (ug/l)	<3	<3	<3	<3	<3	<3	<3	ND
Purgeable organics* (ug/l)	<10	<10	<10	<10	<10	<10	<10	NA

NOTES: NA = not analyzed.
ND = none detected.
Trace = peak detected, but less than stated detection limit.

*Holding time was exceeded.
†Oil and grease values for sediments are in mg/kg dry weight.

Table 14. Results of Analyses of Samples Collected in the Vicinity of Landfill D-41, November 1982

Parameter	Groundwater				Surface Water
	A	B	C	D	E
pH	4.4	4.8	4.5	5.6	6.4
Specific conductance (umhos/cm)	36	74	79	181	59
TOC (mg/l)	681	210	180	1,760	2
TOX (mg Cl^-/l)	<0.05	0.05	0.09	0.13	<0.05
Oil and grease (mg/l)	<5	<5	<5	<5	<5
Phenolics (ug/l)	<1	<1	6	7	2
Purgeable organics (ug/l)	<10	<10	<10	<10	<10

Table 15. Results of Analyses of Samples Collected in the Vicinity of Landfill D-41, February 1983

Parameter	Groundwater				Surface Water
	A	B	C	D	E
pH	5.0	5.0	5.0	5.5	5.3
Specific conductance (umhos/cm)	41	60	70	181	51
DOC (mg/l)*	9	11	26	21	15
TOX (mg Cl^-/l)	<0.05	<0.05	0.06	0.10	<0.05
Oil and grease (mg/l)	<5	7	8	6	<5
Phenolics (ug/l)	<1	<1	<1	<1	<1
Purgeable organics (ug/l)*	<10	<10	<10	<10	<10

*Holding time was exceeded.

Table 16. Results of Analyses of Samples Collected in the Vicinity of Landfill D-40, November 1982

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D
pH	4.4	6.4	6.3	6.1
Specific conductance (umhos/cm)	59	87	132	299
TOC (mg/l)	33	44	10	43
TOX (mg Cl^-/l)	0.05	<0.05	<0.05	0.05
Oil and grease (mg/l)	6	<5	6	<5
Phenolics (ug/l)	<1	2	2	<1
Purgeable organics (ug/l)	<10	<10	<10	<10

Table 17. Results of Analyses of Samples Collected in the Vicinity of Landfill D-40, February 1983

Parameter	Groundwater A	Groundwater B	Groundwater C	Groundwater D
pH	5.0	5.0	5.3	5.5
Specific conductance (umhos/cm)	67	69	112	757
DOC (mg/l)*	31	13	24	25
TOX (mg Cl^-/l)	0.06	0.05	0.07	0.06
Oil and grease (mg/l)	<5	<5	<5	<5
Phenolics (ug/l)	<1	<1	<1	<1
Purgeable organics (ug/l)*	<10	<10	<10	<10

*Holding time was exceeded.

Table 18. Concentration of Specific Pesticides Found in Landfill Samples

Location Time	D-1B Nov.	D-1B Feb.	D-2E, Water Nov.	D-2E, Sed. Nov.	D-7C Nov.	D-26B Nov.
o,p DDE	1.3	0.06	0.57	9.8	0.12	--
p,p DDE	0.40	0.20	<0.03	3.1	0.96	--
o,p DDD	0.04	0.03	<0.05	<0.71	0.18	--
o,p DDT	<0.06	<0.03	<0.08	<1.2	0.13	--
p,p DDD	0.35	0.28	<0.06	2.5	1.1	--
p,p DDT	0.32	0.06	<0.10	<1	0.48	--
Total DDT-R	2.4	0.7	0.7	16	3.0	--
Endrin Aldehyde	---	---	---	---	---	0.54

NOTE: All values in ppb (ug/l or ug/kg).

Table 19. Results of Analyses of Samples Collected in July 1983 (Page 1 of 2)

LANDFILL D-1	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F	Leachate G
Specific conductance (umhos/cm)	144	155	273	51	141	139	369
DOC (mg/l)	34	53	90	43	41	34	70
Purgeable organics (ug/l)	20*	<10	Trace**	<10	<10	<10	<10

LANDFILL D-2	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E
Specific conductance (umhos/cm)	51	232	351	31	63
DOC (mg/l)	48	71	42	34	46
Purgeable organics (ug/l)	<10	<10	<10	<10	<10

LANDFILL D-3	Groundwater A	Groundwater B	Groundwater C	Groundwater D	Surface Water E	Surface Water F
Specific conductance (umhos/cm)	54	724	29	841	798	270
DOC (mg/l)	38	71	53	63	41	46

LANDFILL D-7	Groundwater A	Surface Water B	Surface Water D
Specific conductance (umhos/cm)	31	138	58
DOC (mg/l)	46	68	56
Purgeable organics (ug/l)	<10	<10	<10

Table 19. Results of Analyses of Samples Collected in July 1983 (Page 2 of 2)

LANDFILL D-26	Groundwater A	B	C	D	Surface Water E	F
Specific conductance (umhos/cm)	27	844	387	38	200	71
DOC (mg/l)	36	36	62	55	43	41
Purgeable organics (ug/l)	<10	<10	<10	<10	<10	<10

LANDFILL D-41	Groundwater A	B	C	D	Surface Water E
Specific conductance (umhos/cm)	35	76	77	135	53
DOC (mg/l)	48	51	53	82	35
Purgeable organics (ug/l)	<10	<10	<10	<10	<10

LANDFILL D-40	Groundwater A	B
Specific conductance (umhos/cm)	72	54
DOC (mg/l)	56	45
Purgeable organics (ug/l)	<10	<10

NOTES: Trace = peak detected, but less than stated detection limit.

*Chloroform 20 ug/l.
*Dichloroethylene and trichloroethylene estimated at approximately 3 and 4 ug/l, respectively.

Table 20. State of Florida Standards for Surface Water and Groundwater

PARAMETER	Class G-II Groundwater Standards	Class III Surface Water Standards
pH	6.5 min*	6-8.5*
Specific conductance (umhos/cm)	-	500 max
Oil and grease (mg/l)	-	5
Phenolics (ug/l)	-	1†
Arsenic (ug/l)	50	50
Cadmium (ug/l)	10	0.8-1.2**
Chromium (ug/l)	50	50
Lead (ug/l)	50	30
Mercury (ug/l)	2	0.2
Nickel (ug/l)	-	100
Silver (ug/l)	50	0.07
Zinc (mg/l)	5.0	30
Organochlorine pesticides (ug/l)	0.2-100††	0.001 (for DDT)
2,4-D (ug/l)	100	-
Silvex (ug/l)	10	-
Trihalomethanes (ug/l)	100	-

*Or natural background.
†For certain specified phenolic compounds (17-3.061).
**Depends on water hardness.
††Depends on compound.

Source: Florida Administrative Code Chapters 17-3 and 17-22.

Table 21. Estimated Groundwater Flow Rates and Estimated Discharge to Surface Water at Phase II Study Sites, Eglin AFB, Florida

Site	Hydraulic Conductivity, (K)(m/sec)	Hydraulic Gradient, (I)	Assumed Porosity, (P)	Estimated Flow Rate, (q) (m/sec)	Longest Flow Path, d(m)	Time to Travel Flow Path (days)	Front of Discharge, f(m)	Depth of Wastes (m)	Estimated Discharges, Q(m^3/sec, and gpm)	Surface Water
D-1	2.15×10^{-3}	2.14×10^{-3}	0.40	1.2×10^{-5}m/sec	1,550	1,560	790	2	1.9×10^{-2}(250)	Choctawhatchee Bay
D-2	7.66×10^{-4}	2.90×10^{-3}	0.40	5.6×10^{-6}m/sec	730	1,520	—	--	—	—
D-3	7.16×10^{-4}	1.10×10^{-3}	0.40	2.0×10^{-6}m/sec	120	705	300	2	1.2×10^{-3}(16)	Stream NW of D-3
D-26	8.52×10^{-4}	7.66×10^{-3}	0.40	1.6×10^{-5}m/sec	200	140	300	1.5	7.2×10^{-3}(96)	East Bay Swamp
D-41	3.78×10^{-4}	5.16×10^{-3}	0.40	4.9×10^{-6}m/sec	90	210	90	1	4.4×10^{-4}(6)	East Bay Swamp
D-40	1.71×10^{-3}	1.67×10^{-3}	0.40	7.1×10^{-6}m/sec	30	50	60	1	4.3×10^{-4}(6)	Santa Rosa Sound

Front of Discharge = width of disposal site perpendicular to assumed direction of flow.

Table 22. EPA List of 129 Priority Pollutants and the Relative Frequency of these Materials in Industrial Wastewaters (Page 1 of 4)

Percent of Samples*	Number of Industrial Categories**	Parameter
31 are purgeable organics		
1.2	5	Acrolein
2.7	10	Acrylonitrile
29.1	25	Benzene
29.3	28	Toluene
16.7	24	Ethylbenzene
7.7	14	Carbon tetrachloride
5.0	10	Chlorobenzene
6.5	16	1,2-Dichloroethane
10.2	25	1,1,1-Trichloroethane
1.4	8	1,1-Dichloroethane
7.7	17	1,1-Dichloroethylene
1.9	12	1,1,2-Trichloroethane
4.2	13	1,1,2,2-Tetrachloroethane
0.4	2	Chloroethane
1.5	1	2-Chloroethyl vinyl ether
40.2	28	Chloroform
2.1	5	1,2-Dichloropropane
1.0	5	1,3-Dichloropropene
34.2	25	Methylene chloride
1.9	6	Methyl chloride
0.1	1	Methyl bromide
1.9	12	Bromoform
4.3	17	Dichlorobromomethane
6.6	11	Trichlorofluoromethane
0.3	4	Dichlorodifluoromethane
2.5	15	Chlorodibromomethane
10.2	19	Tetrachloroethylene
10.5	21	Trichloroethylene
0.2	2	Vinyl chloride
7.7	18	1,2-trans-Dichloroethylene
0.1	2	bis (Chloromethyl) ether
46 are base/neutral extractable organic compounds		
		1,2-Dichlorobenzene
6.0	9	1,3-Dichlorobenzene
		1,4-Dichlorobenzene
0.5	5	Hexachloroethane
0.2	1	Hexachlorobutadiene

Table 22. EPA List of 129 Priority Pollutants and the Relative Frequency of these Materials in Industrial Wastewaters (Page 2 of 4)

Percent of Samples*	Number of Industrial Categories**	Parameter
1.1	7	Hexachlorobenzene
1.0	6	1,2,4-Trichlorobenzene
0.4	3	bis (2-Chloroethoxy) methane
10.6	18	Naphthalene
0.9	9	2-Chloronaphthalene
1.5	13	Isophorone
1.8	9	Nitrobenzene
1.1	3	2,4-Dinitrotoluene
1.5	9	2,6-Dinitrotoluene
0.04	1	4-Bromophenyl phenyl ether
41.9	29	bis (2-Ethylhexyl) phthalate
6.4	12	Di-n-octyl phthalate
5.8	15	Dimethyl phthalate
7.6	20	Diethyl phthalate
16.9	23	Di-n-butyl phthalate
5.7	11	Fluorene
7.2	12	Fluoranthene
5.1	9	Chrysene
7.8	14	Pyrene
10.6	16	Phenanthrene Anthracene
2.3	6	Benzo(a)anthracene
1.6	6	Benzo(b)fluoranthene
1.8	6	Benzo(k)fluoranthene
3.2	8	Benzo(a)pyrene
0.8	4	Indeno(1,2,3-c,d)pyrene
0.2	4	Dibenzo(a,h)anthracene
0.6	7	Benzo(g,h,i)perylene
0.1	2	4-Chlorophenyl phenyl ether
0	0	3,3'-Dichlorobenzidine
0.2	4	Benzidine
1.1	4	bis(2-Chloroethyl) ether
0.8	7	1,2-Diphenylhydrazine
0.1	1	Hexachlorocyclopentadiene
1.2	5	N-Nitrosodiphenylamine
4.5	12	Acenapnthylene
4.2	14	Acenaphthene
8.5	13	Butyl benzyl phthalate

Table 22. EPA List of 129 Priority Pollutants and the Relative Frequency of these Materials in Industrial Wastewaters (Page 3 of 4)

Percent of Samples*	Number of Industrial Categories**	Parameter
0.1	1	N-Nitrosodimethylamine
0.1	2	N-Nitrosodi-n-propylamine
1.4	6	bis(2-Chloroisopropyl) ether
11 are acid extractable organic compounds		
26.1	25	Phenol
2.3	11	2-Nitrophenol
2.2	9	4-Nitrophenol
1.6	6	2,4-Dinitrophenol
1.1	6	4,6-Dinitro-o-cresol
6.9	18	Pentachlorophenol
1.9	8	p-Chloro-m-cresol
2.3	10	2-Chlorophenol
3.3	12	2,4-Dichlorophenol
4.6	12	2,4,6-Trichlorophenol
5.2	15	2,4-Dimethylphenol
26 are pesticides/PCBs		
0.3	3	α-Endosulfan
0.4	4	β-Endosulfan
0.2	2	Endosulfan sulfate
0.6	4	α-BHC
0.8	6	β-BHC
0.2	4	γ-BHC
0.5	3	δ-BHC
0.5	5	Aldrin
0.1	3	Dieldrin
0.04	1	4,4'-DDE
0.1	2	4,4'-DDD
0.2	2	4,4'-DDT
0.2	3	Endrin
0.2	2	Endrin aldehyde
0.3	3	Heptachlor
0.1	1	Heptachlor epoxide
0.2	4	Chlordane
0.2	2	Toxaphene
0.6	2	Arochlor 1016

Table 22. EPA List of 129 Priority Pollutants and the Relative Frequency of these Materials in Industrial Wastewaters (Page 4 of 4)

Percent of Samples*	Number of Industrial Categories**	Parameter
0.5	1	Aroclor 1221
0.9	2	Aroclor 1232
0.8	3	Aroclor 1242
0.6	2	Aroclor 1248
0.6	3	Aroclor 1254
0.5	1	Aroclor 1260
---	--	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
13 are metals		
18.1	20	Antimony
19.9	19	Arsenic
14.1	18	Beryllium
30.7	25	Cadmium
53.7	28	Chromium
55.5	28	Copper
43.8	27	Lead
16.5	20	Mercury
34.7	27	Nickel
16.9	21	Selenium
22.9	25	Silver
19.2	19	Thallium
54.6	28	Zinc
Miscellaneous		
33.4	19	Total cyanides
Not available		Asbestos (fibrous)
Not available		Total phenols

Source: NRDC Consent Agreement and Committee Print 95-30. 1977. Data Relating to H.R. 3199 (Clean Water Act of 1977). Committee on Public Works and Transportation, 95th Congress, 1st Session. Government Printing Office.

*The percent of samples represents the number of times this compound was found in all samples in which it was analyzed for divided by the total as of 31 August 1978. Numbers of samples ranged from 2532 to 2998 with the average being 2617.

**A total of 32 industrial categories and subcategories were analyzed for organics and 28 for metals as of 31 August 1978.

8.0 FIGURES

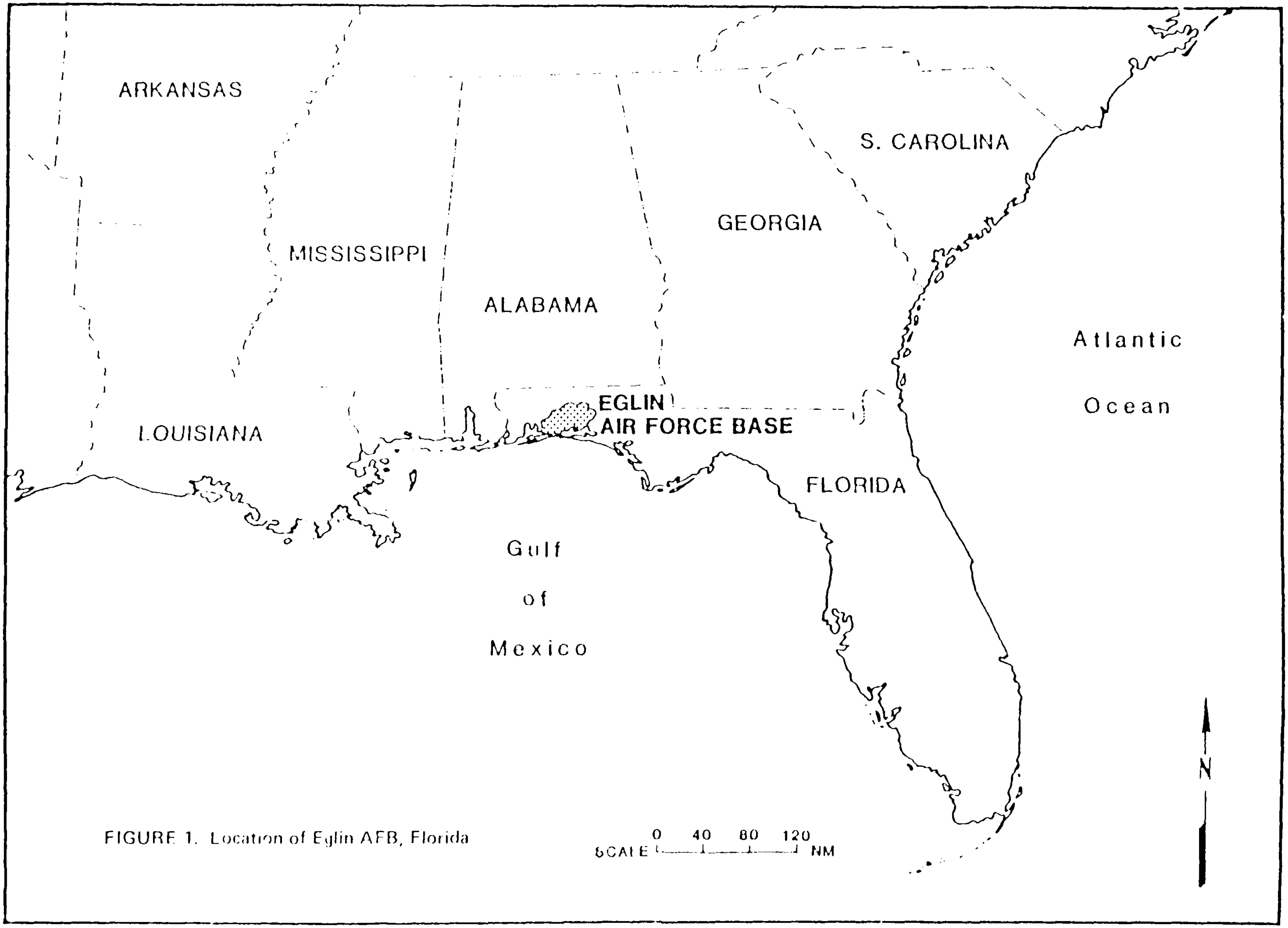


FIGURE 1. Location of Eglin AFB, Florida

SOURCE: Christopher et al., 1981

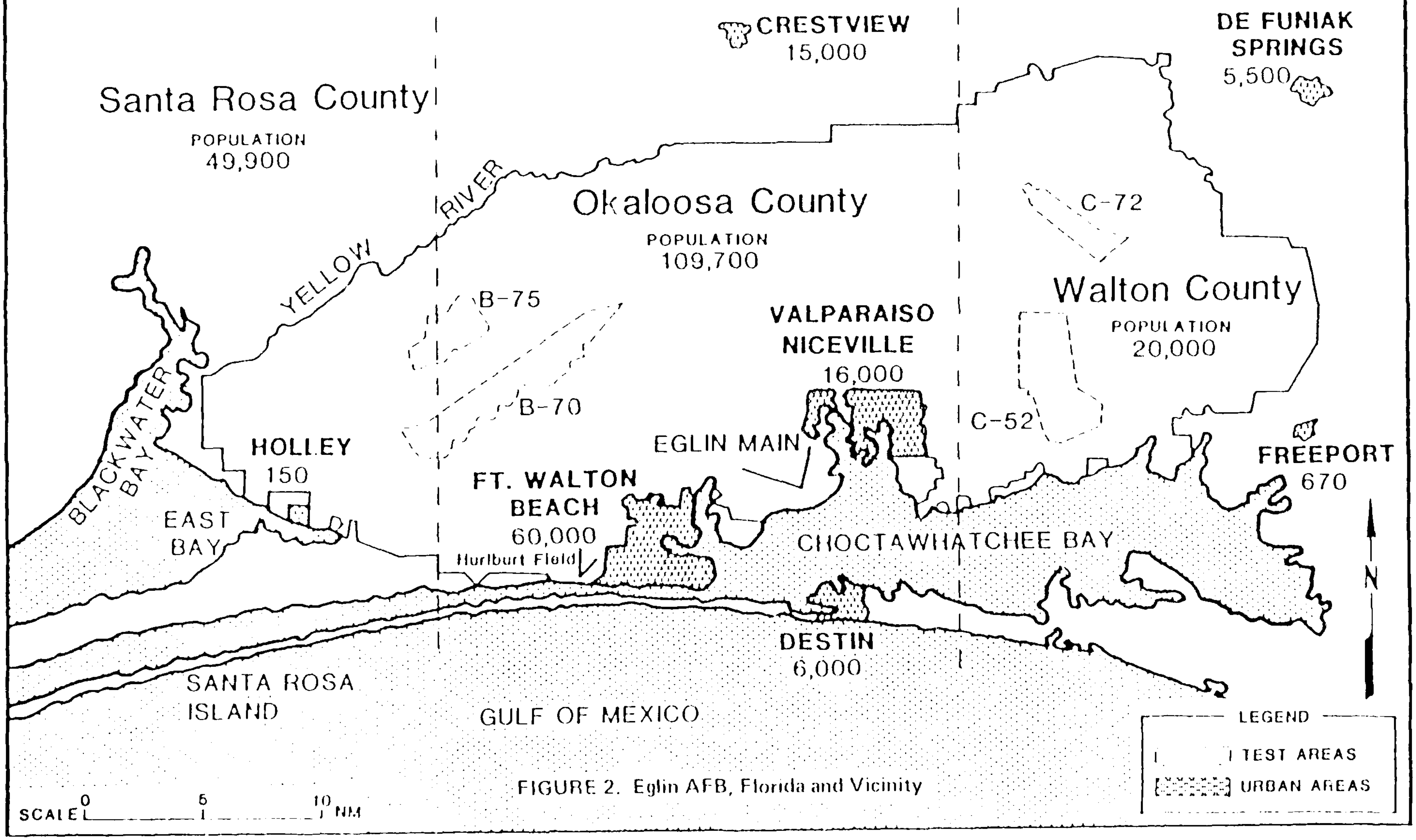


FIGURE 2. Eglin AFB, Florida and Vicinity

SOURCE: Christopher et al., 1981.

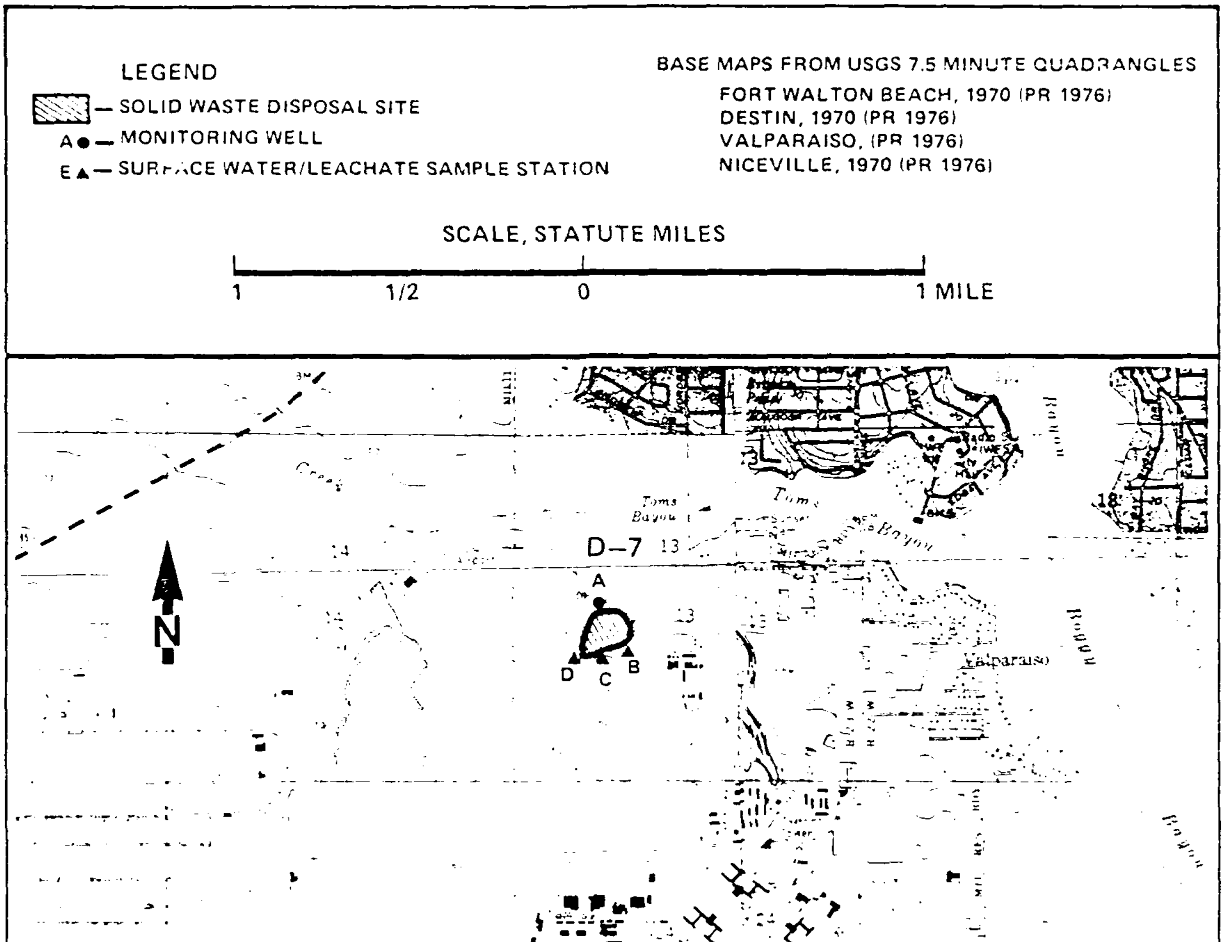


FIGURE 3. Study Areas and Sample Stations at Eglin Main, Eglin AFB, Florida, 1982 83

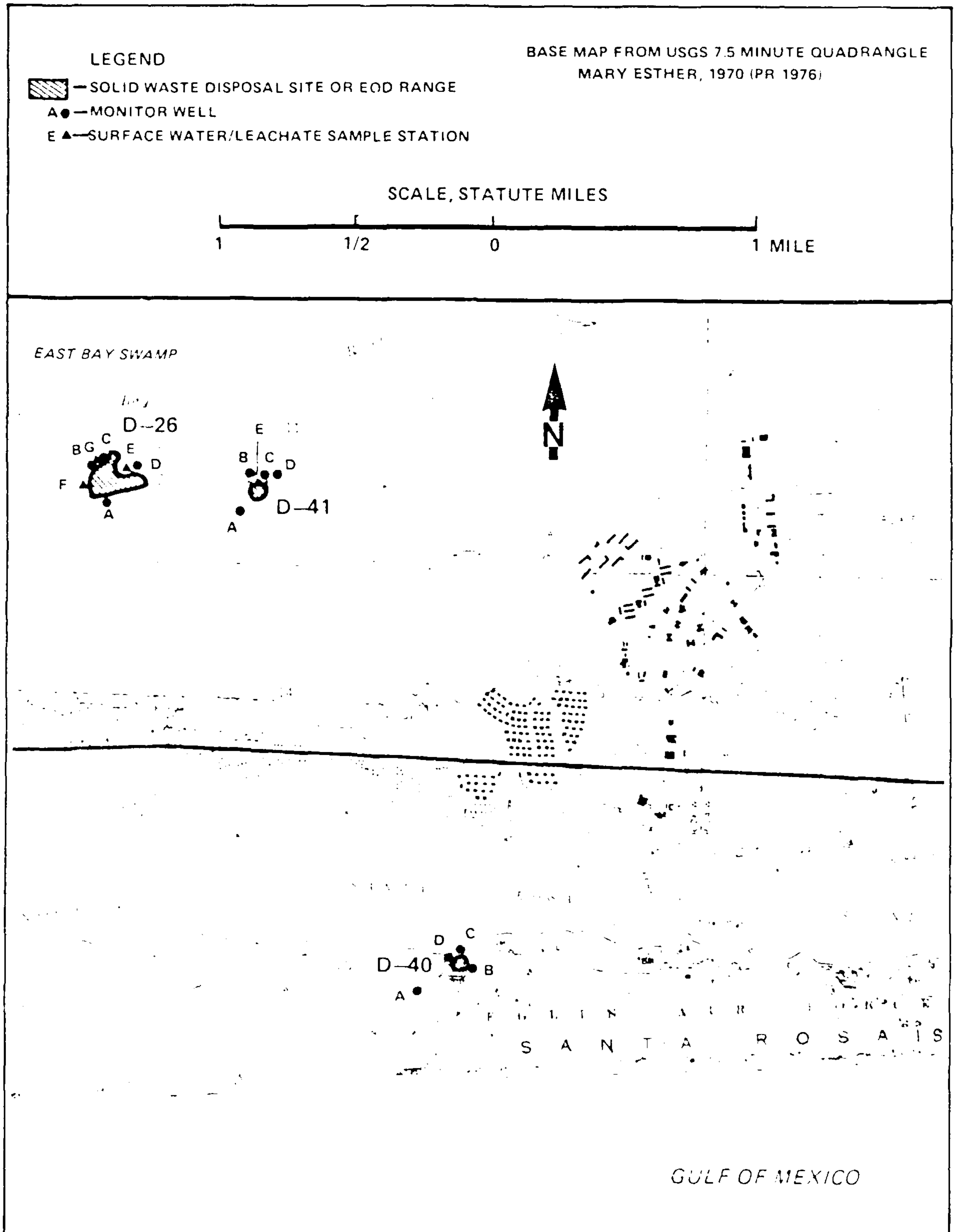


FIGURE 4. Study Areas and Sample Stations at Hurlburt Field and Santa Rosa Island, Eglin AFB, Florida, 1982-83

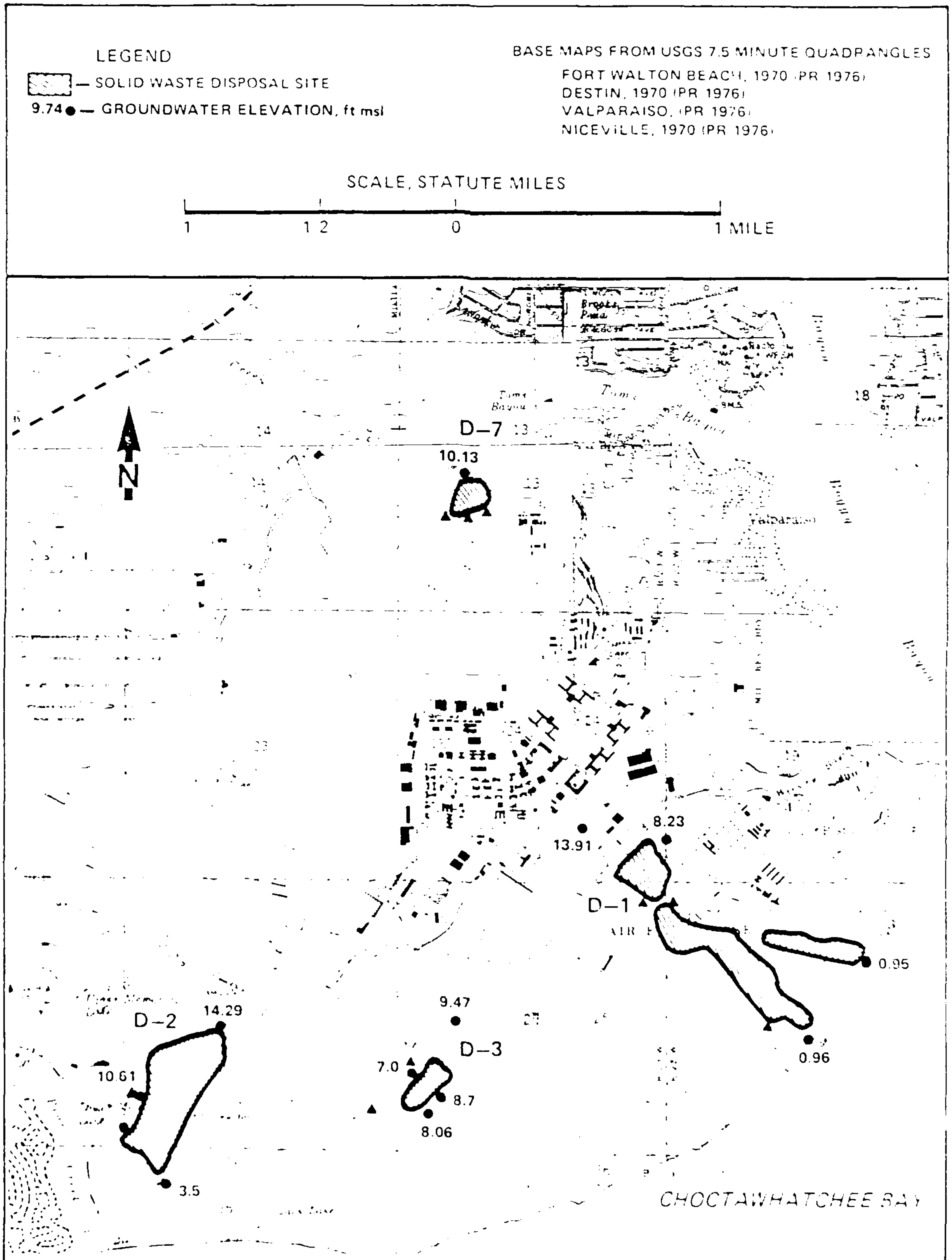


FIGURE 5. Groundwater Elevations at Eglin Main, Eglin AFB, November 1982

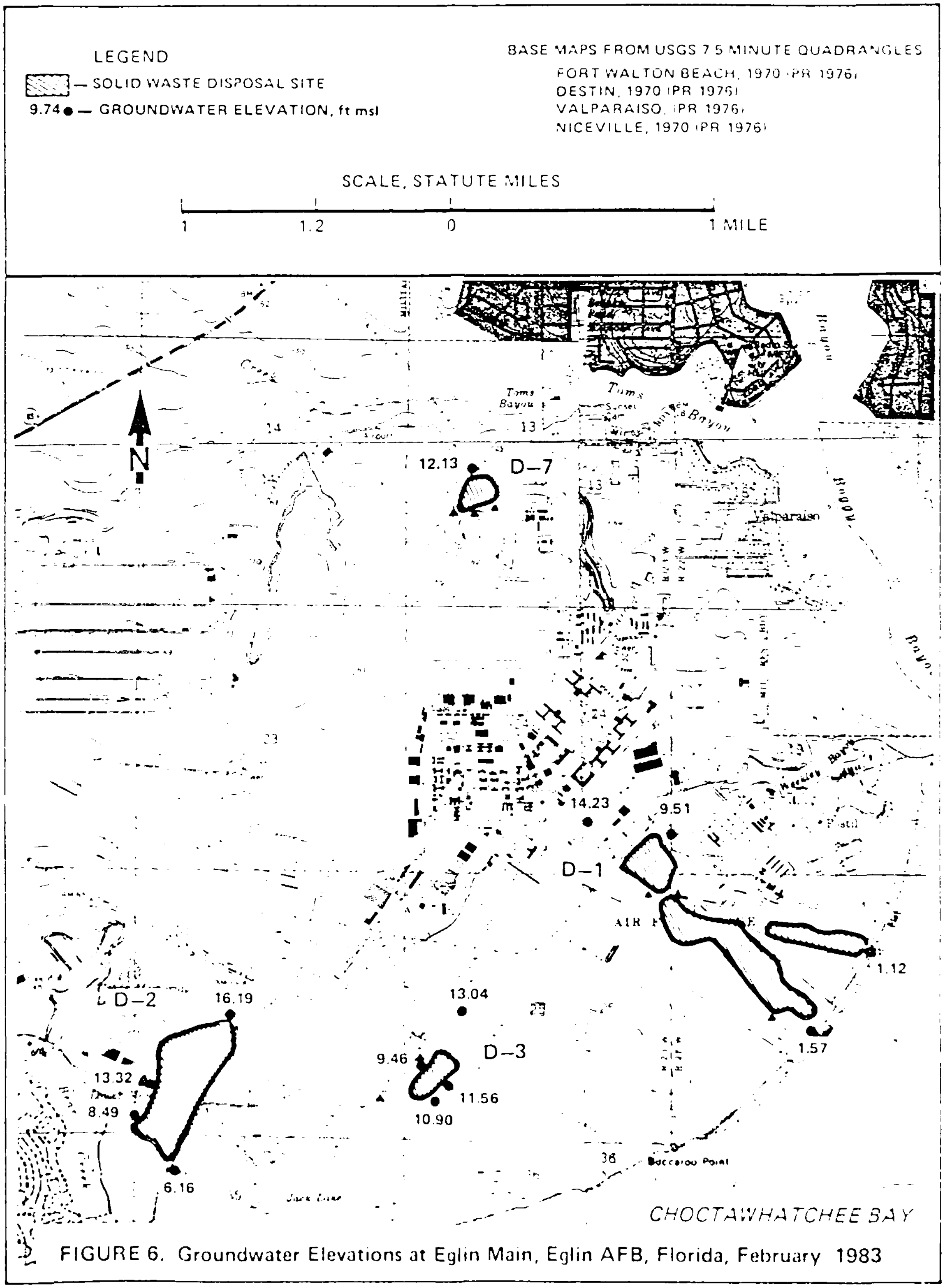


FIGURE 6. Groundwater Elevations at Eglin Main, Eglin AFB, Florida, February 1983

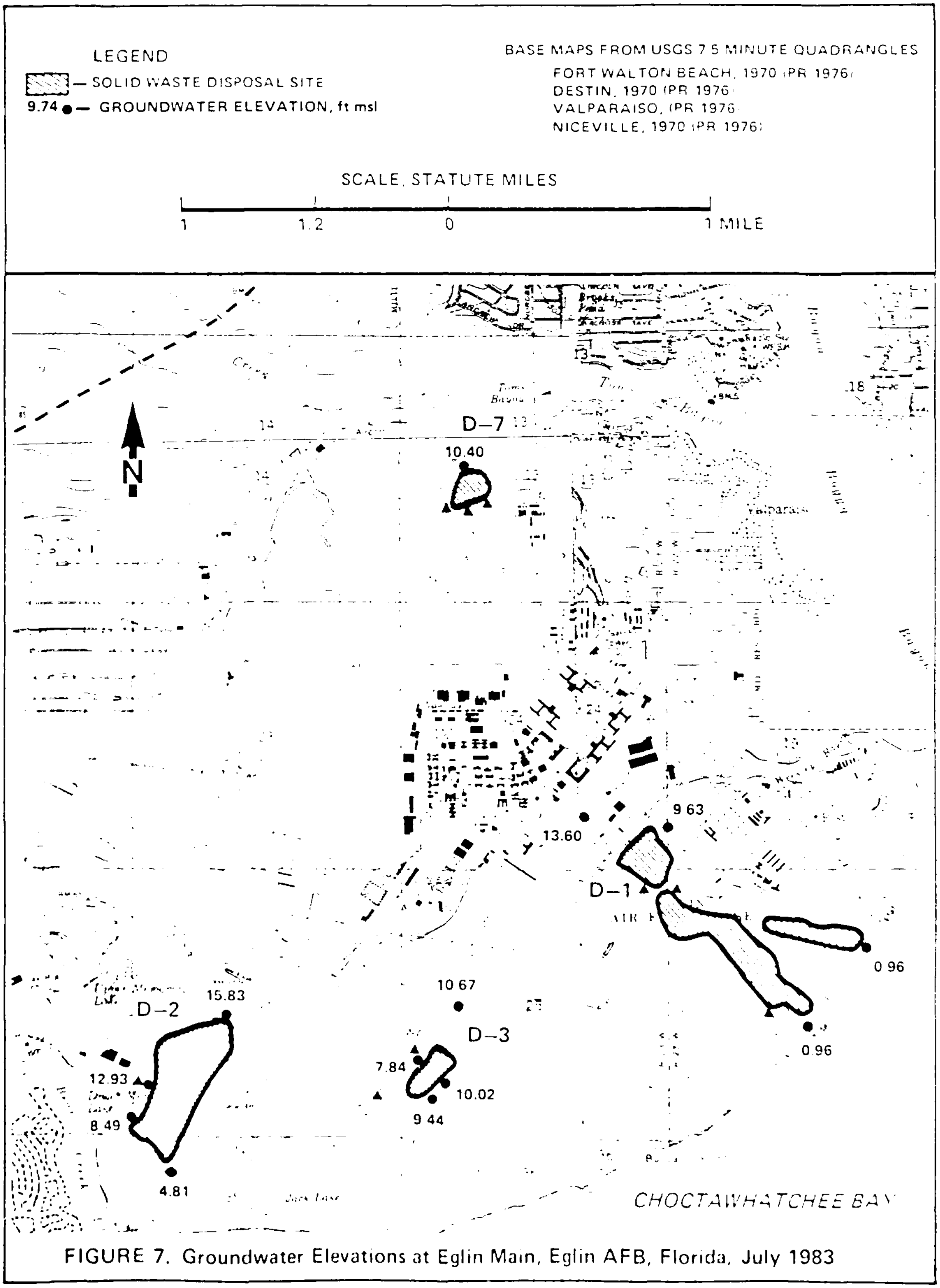


FIGURE 7. Groundwater Elevations at Eglin Main, Eglin AFB, Florida, July 1983

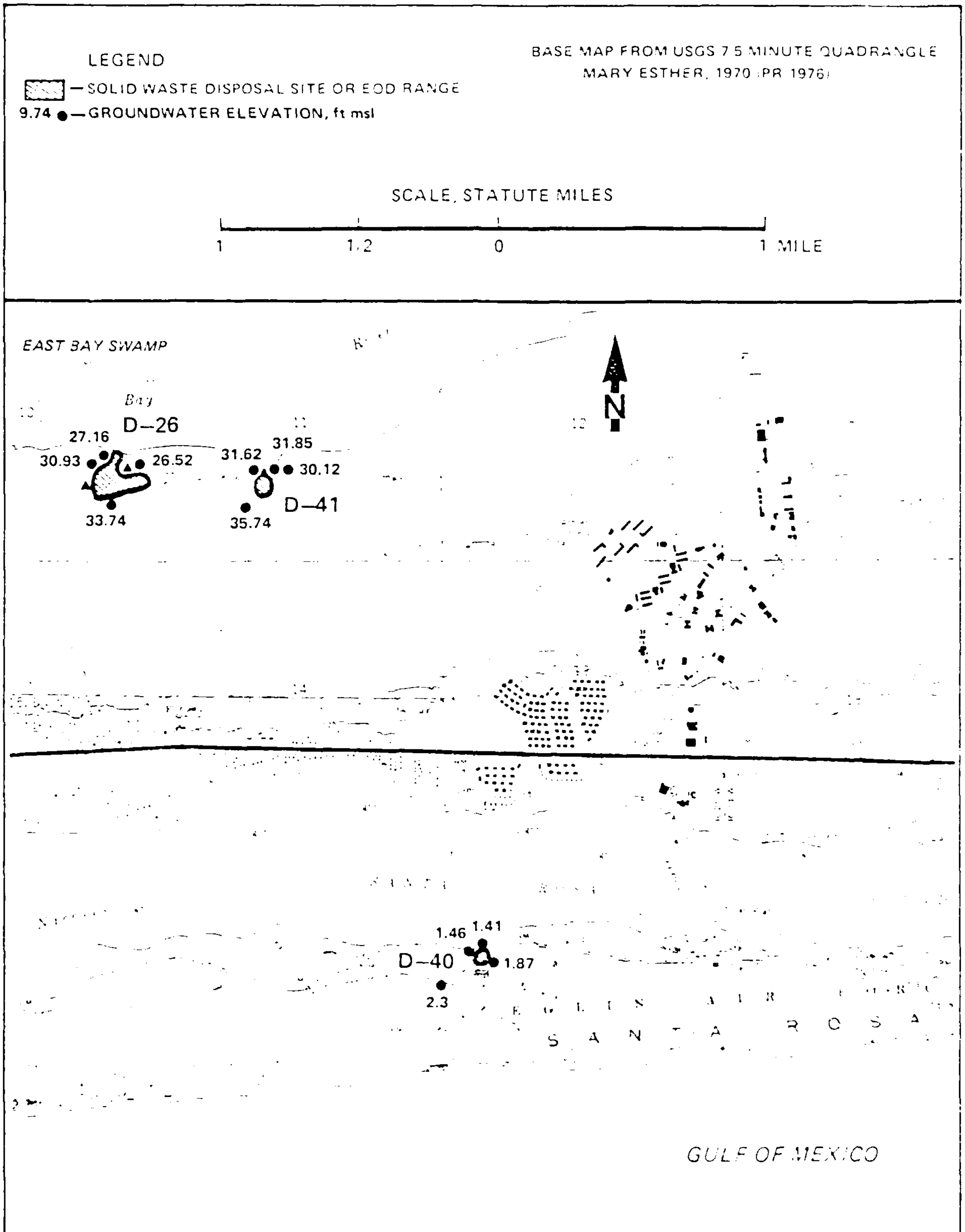


FIGURE 8. Groundwater Elevations at Hurlburt Field and Santa Rosa Island, Eglin AFB, November 1982

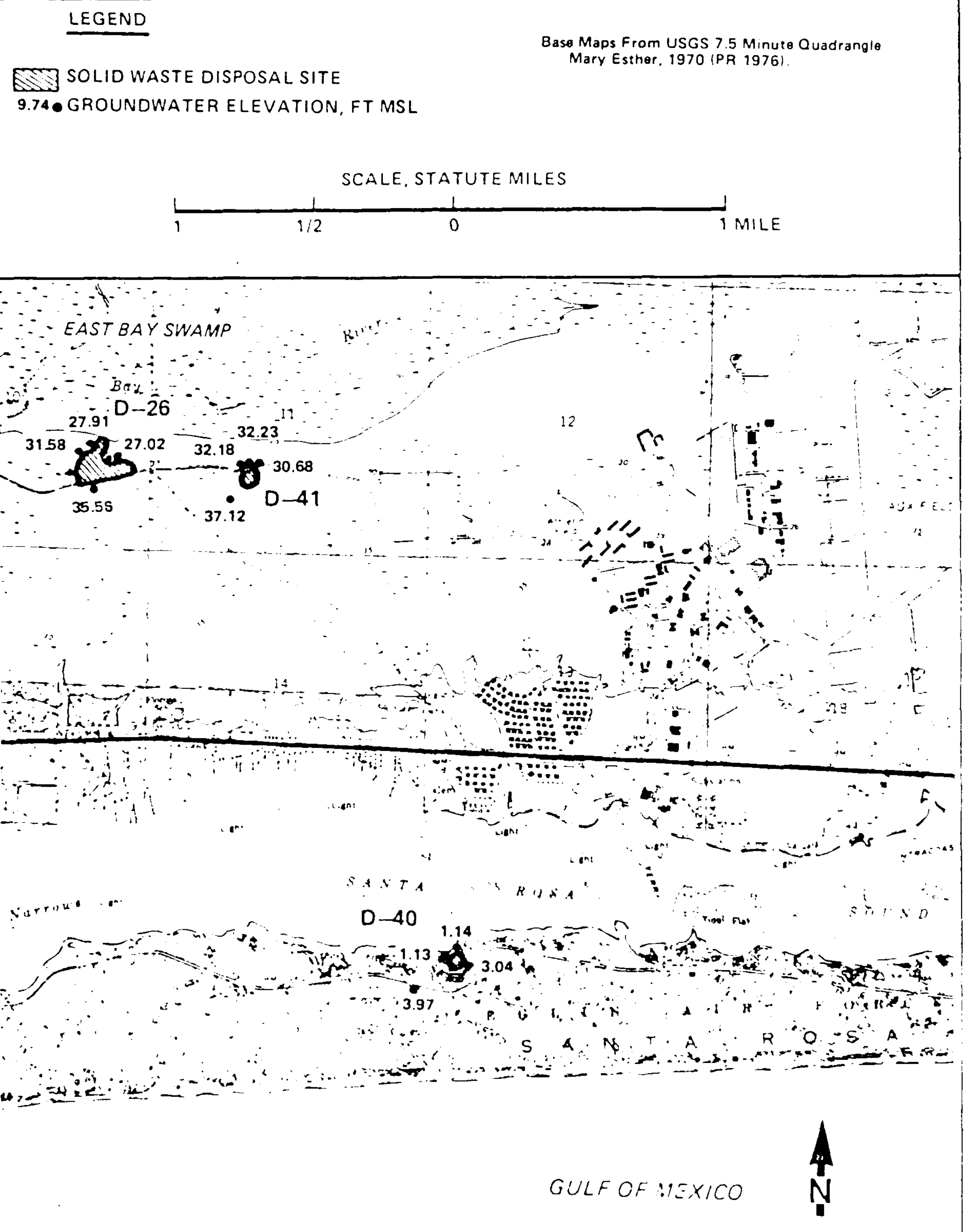


FIGURE 9. Groundwater Elevations at Hurlburt Field and Santa Rosa Island, Eglin AFB, Florida, February, 1983

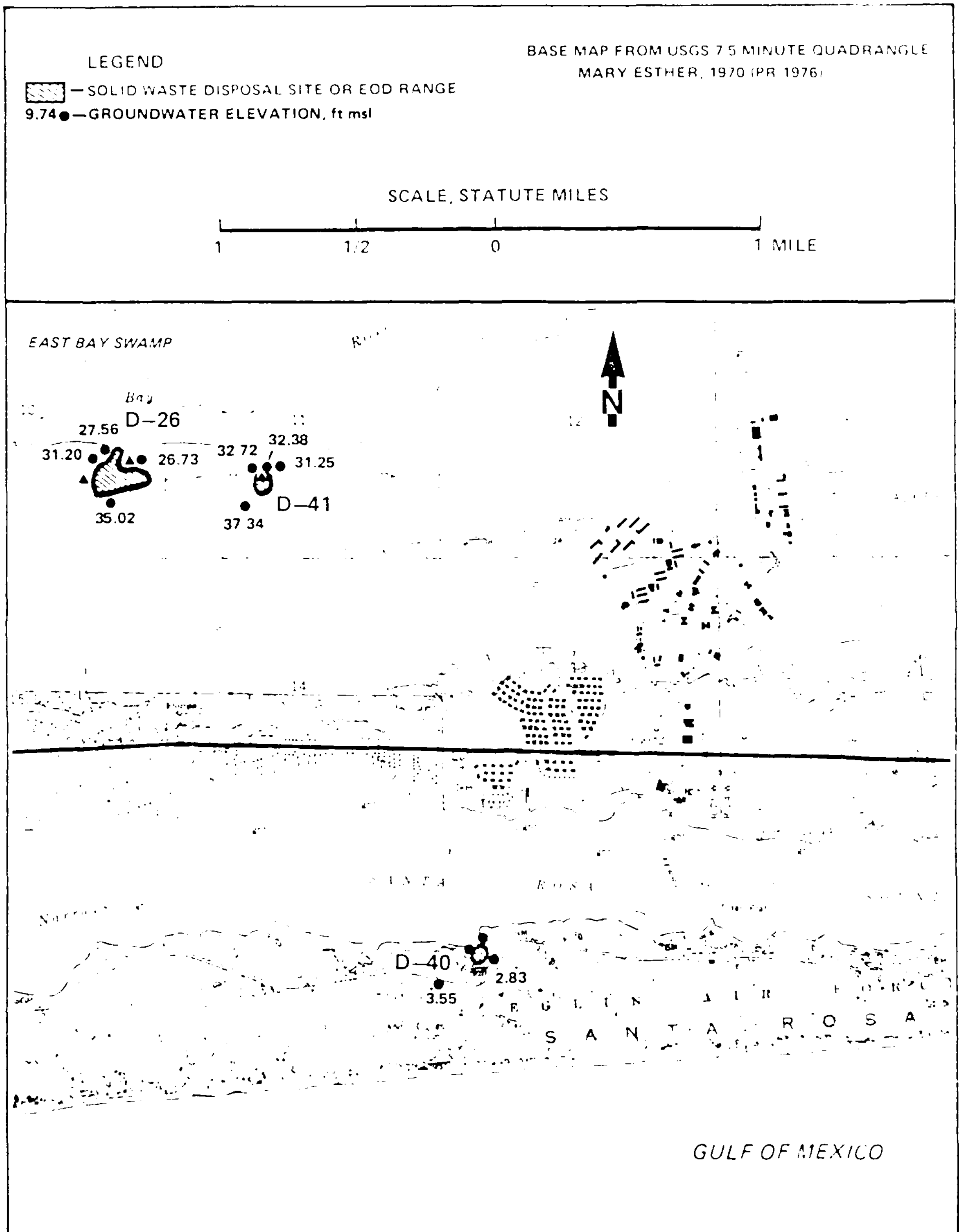


FIGURE 10. Groundwater Elevations at Hurlburt Field and Santa Rosa Island, Eglin AFB, Florida, July 1983

9.0 REFERENCES

9.0 REFERENCES

Barr, D.E., A. Maristany, and T. Kwader. 1981. Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida--Summary Investigation. Northwest Florida Water Management District. Water Resources Assessment 81-1. 41 p.

Bradley, J.T. 1972. The Climate of Florida. Reprinted in: Climates of the States, Vol. 1. 1974. Water Information Center. Port Washington, New York.

Brooks, H.K. 1981. Physiographic Divisions of Florida. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Christopher, W.G. et al., 1981. Installation Restoration Program, Phase I Records Search, Hazardous Materials Disposal Sites, Eglin AFB, Florida. Prepared for United States Air Force AFESC/DEV, Tyndall AFB, Florida. Contract No. F08637-80-G-0009-002.

Food and Drug Administration. 1981. Action Level for Poisonous or Deleterious Substances in Human Food and Animal Feed. Washington, D.C. 13 pp.

Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, N.J. 604 p.

Harrison, D.D., C.I. Miller, and R.C. Crews. 1979. Residual levels of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD) near herbicides storage and Loading Areas at Eglin AFB, Florida. AFATL-TR-79-20. Air Force Armament Laboratory. Eglin AFB, Florida.

Hartman, R.A. and H.L. Postrozny. 1984. Personal communication. AD/DEV, Eglin AFB, Florida.

Hayes, L.R. and D.E. Barr. 1983. Hydrology of the sand-and-gravel aquifer, southern Okaloosa and Walton Counties, Northwest Florida. U.S. Geological Survey. Water Resources Investigations Report 82-4110.

Naval Facilities Engineering Command. 1982. Soil Mechanics, Design Manual 7.1. Alexandria, Virginia. pp 7.1-105 - 7.1-108.

Strausberg, S.I. 1982. Permeability from "mini-rate" pumping tests. Groundwater Monitoring Review. Vol 2. No 3. pp 25-26.

U.S. Environmental Protection Agency (EPA). 1984. Ambient Water Quality Criteria for 2,3,7,8-tetrachloro-dibenzo-p-dioxin. Washington, D.C.

Young, A.L., J.A. Calcagni, C.E. Thalken, and J.W. Tremblay. 1978. The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and its Associated Dioxin. OEHL TR-78-92. USAF Occupational and Environmental Health Laboratory. Brooks AFB, Texas.

APPENDICES

APPENDIX A

FIELD METHODS

APPENDIX A

FIELD METHODS

A-1.0 WELL INSTALLATION

Each monitor well was constructed so that it had both an efficient hydraulic connection to the surrounding water table aquifer and an effective seal against the migration of surface waters into the borehole. Special care was taken to protect against cross-contamination between wells.

The following techniques and materials were used to accomplish these aims (Figure A-1):

1. Hollow-stem augers (7 7/8 inches outside diameter) were used to drill borehole to approximately 10 feet below the water table, as noted during drilling. Representative lithologic samples were collected by ASTM D-1586-67 every 5 feet for preparation of the lithologic log (Appendix B).
2. A string of clean, threaded, flush-joint, 2-inch, schedule 40 polyvinyl chloride (PVC) well casing and 10-foot screen (0.010-inch slot) was installed through the hollow-stem augers. The top of the casing was approximately 12 to 18 inches above ground level.
3. The augers were withdrawn allowing sand below the water table to collapse around the screen, forming a native sand filter pack. Additional sand was placed in the hole to bring the sand to approximately 3 to 5 feet below land surface.
4. A 1- to 2-foot seal of bentonite was placed on top of the sand. At some wells, the hole collapsed to within 2 feet of the ground surface when the augers were withdrawn. In these instances, the bentonite seal was not installed.
5. The remainder of the annular space was filled with a sand-cement (2:1) grout.
6. A 5-foot-long, 6-inch, steel protective casing was installed approximately 3 feet into the grout and equipped with a padlock.

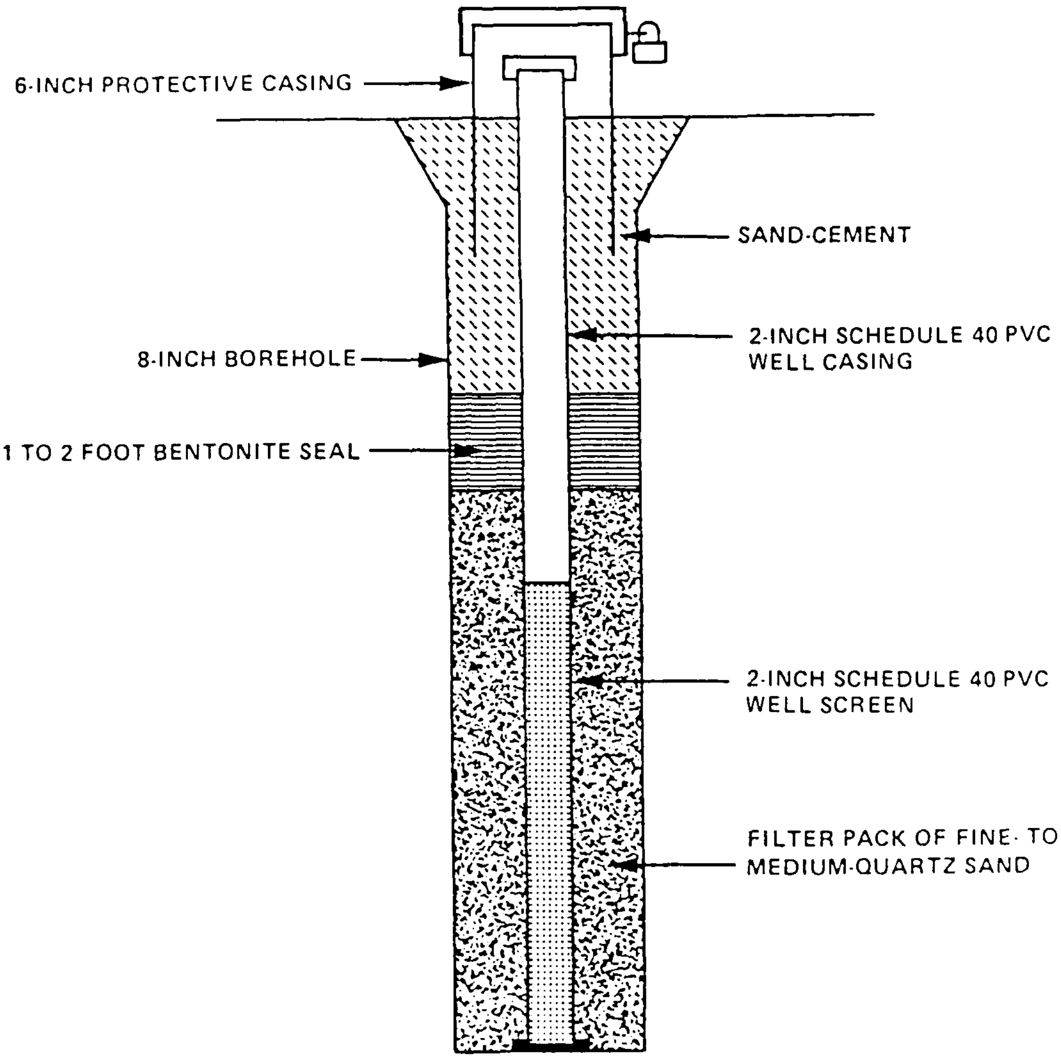


FIGURE A–1. Monitoring Well Construction Detail

The aboveground portions of both the PVC casing and the protective casing were vented.

7. Each well was developed by bailing at least five well volumes following installation.
8. All down-hole tools were washed with potable water between holes to prevent cross-contamination. All well casings and screens were washed with potable water before installation.
9. Each person working at a well wore the following safety equipment: hard hat, steel-toed rubber boots, elbow-length rubber gloves, and disposable coveralls. Coveralls were changed at least daily.

A-2.0 SAMPLE COLLECTION

A-2.1 GROUNDWATER SAMPLING

Groundwater sampling was performed November 9-12, 1982 and February 12-15, 1983 and consisted of the following tasks:

1. Before sampling or purging the Eglin AFB monitoring wells, the distance from the top of the 2-inch PVC well casing to the water surface was measured.
2. WAR personnel routinely removed five well volumes from observation wells that could not be pumped to dryness before sampling. Only one well (D-26D) at Eglin was found that could be pumped to dryness. In that case, the well was pumped to dryness and a sample was collected after it had recovered.
3. The WAR field team used a plastic "Guzzler" hand pump during the November 1982 sampling and a gasoline powered (Honda WA-15) pump during the February 1983 trip. Both pumps performed satisfactorily; however the gasoline powered pump seemed to be more effective in removing sediment from the bottom of the well. This was evidenced by an apparent decrease in the amount of sediment collected by the bailer during the February 1983 trip. During both sampling trips, a high density polypropylene tube was used on the inlet side of the pump. Between wells this

tubing was rinsed (both inside and outside) with deionized water, and any remaining fine sediment was removed from the tubing with a paper towel before a second rinsing. Pumping by hand usually required between 5 to 10 minutes per well. To prevent sample contamination (e.g., volatile organics and lead) by gasoline fumes or engine exhaust, the gasoline tank was not filled near wells or the van and any spillage was allowed to evaporate before moving the pump. During use, the pump was placed downwind from wells whenever there was wind.

4. Immediately prior to sample collection, three bailer volumes of water were removed from the wells and discarded. This was intended to minimize any collector artifacts on the sample even though the bailers had been cleaned in the laboratory and were suspended in the wells (capped) after the initial sampling trip.
5. A "Field Sampling Sheet" was used to document in situ data (i.e., pH, specific conductance, temperature, and depth of water in well) and other pertinent information (i.e., time, date, sample container numbers, comments, and/or observations).
6. The samples were preserved according to the instructions listed in Table A-1, chilled, and transported to WAR's Gainesville, Florida laboratory. Due to analytical problems experienced with the first set of samples (from the November 1982 sampling), the metals and organic carbon samples were filtered through 0.45 micron membrane filters before acidification.

Replicate samples were collected from some wells for quality control purposes [i.e., field replicates and field spikes (see Appendix C)].

The pH of samples preserved by acidification was checked using colorimetric test strips to verify that an appropriate pH had been reached. A portion of the sample was poured onto the test strip and at no time were test strips placed inside the sample container.

Table A-1. Preservation Methods for Water and Soil or Bottom Sediment Samples Collected at Eglin AFB, Florida

Parameter	Phase	Container	Preservation
TOX	Water	4 oz Amberglass	Chill to 4°C; no headspace
Organochlorine insecticides	Water	1 qt Glass	Chill to 4°C
PCBs	"	"	"
Herbicides	"	"	"
Oil and grease	"	"	HCl to pH<2; Chill to 4°C
Phenols	"	"	H_3PO_4 to pH<2; 1 gm $CuSO_4$; Chill to 4°C
Heavy metals	"	1 Plastic	HNO_3 to pH<2; Chill to 4°C
Organic carbon	"	2 oz Plastic	H_2SO_4 to pH<2; Chill to 4°C
Organochlorine insecticides	Soil or Sediment	1 qt Glass	Chill to 4°C
Herbicides	"	"	"
Oil and grease	"	"	"
PCBs	"	"	"

A-2.2 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and bottom sediment samples were collected from Landfills D-1, D-2, D-3, and D-26, while at Landfill D-7 and Site D-41 surface waters were obtained, but not sediments. Water samples were collected from standing water in retention ponds, depressions, and borrow pits and flowing water from seeps, creeks, and ditches.

At all stations, the water depth was less than 3 feet. Samples were collected from just below the surface. As with the groundwater samples, pH, temperature, and specific conductance of surface waters were measured in the field at the time of sample collection. Bottom sediment samples were collected with either a Petite Ponar dredge or the sample container.

A-3.0 AQUIFER TESTS

WAR performed single well aquifer tests at eight wells to determine values of horizontal hydraulic conductivity representative of the surrounding soil. A "mini-rate" pumping test[1] was performed at seven of the wells. At the other well (D-41D), which was near the edge of the East Bay Swamp in soils of somewhat lower hydraulic conductivity, a falling-head test[2] was used.

A-3.1 "MINI-RATE" PUMPING TEST

"Mini-rate" pumping tests at Eglin AFB were performed in the following manner:

1. Several measurements of the static water level were taken after the suction hose of the pump (Honda WA-15) was installed in the well.
2. The pump was started, and frequent water level measurements were taken with an electric tape. Water levels were measured to the

---

[1]Strausberg, S.I. 1982. Permeability from "mini-rate" pumping tests. Groundwater Monitoring Review. Vol 2. No 3. pp 23-26.

[2]Naval Facilities Engineering Command. 1982. Soil Mechanics, Design Manual 7.1. Alexandria, Virginia. pp 7.1-103 - 7.1-106.

nearest 1/8-inch (±0.01-foot). The time pumping started and the times water level measurements were taken by stopwatch and recorded to the nearest second.

3. Pumping rates were checked and recorded periodically.
4. After the water approached a stable level for the pumping rate, the pump was turned off, and water level measurements were taken during the recovery period.

Data from the mini-rate pumping test were reduced as follows:

1. The average pumping rate was calculated.
2. The time since pumping started, t (seconds), and the time since pumping stopped, t' (seconds) were determined.
3. Drawdown or recovery were determined in feet.
4. The data were plotted on semi-log paper as: s (drawdown) vs t (Figure A-2), s' (residual drawdown or recovery) vs t' (Figure A-3), and s' vs t/t' (Figure A-4).

Hydraulic conductivity (K) was calculated by the equation:

$$K = 264\ Q/(\Delta s \times b)$$

where: K = hydraulic conductivity (cm/sec),
Q = pumping rate (gal/min),
Δs = change in drawdown or recovery over one log cycle (ft), and
b = saturated thickness (ft).

Since the pumping rates were low (<10 gal/min), it was assumed that flow to the well was horizontal. Given this assumption, it was possible to ignore the effects of partial penetration and to take b as the thickness of the aquifer opposite the well screen.

The values of hydraulic conductivity obtained by this method were on the order of 6.00×10^{-2} cm/sec to 3.00×10^{-1} cm/sec which are in good agreement with the range of values for clean sand (10^{-4} to 10^{-1} cm/sec)[3].

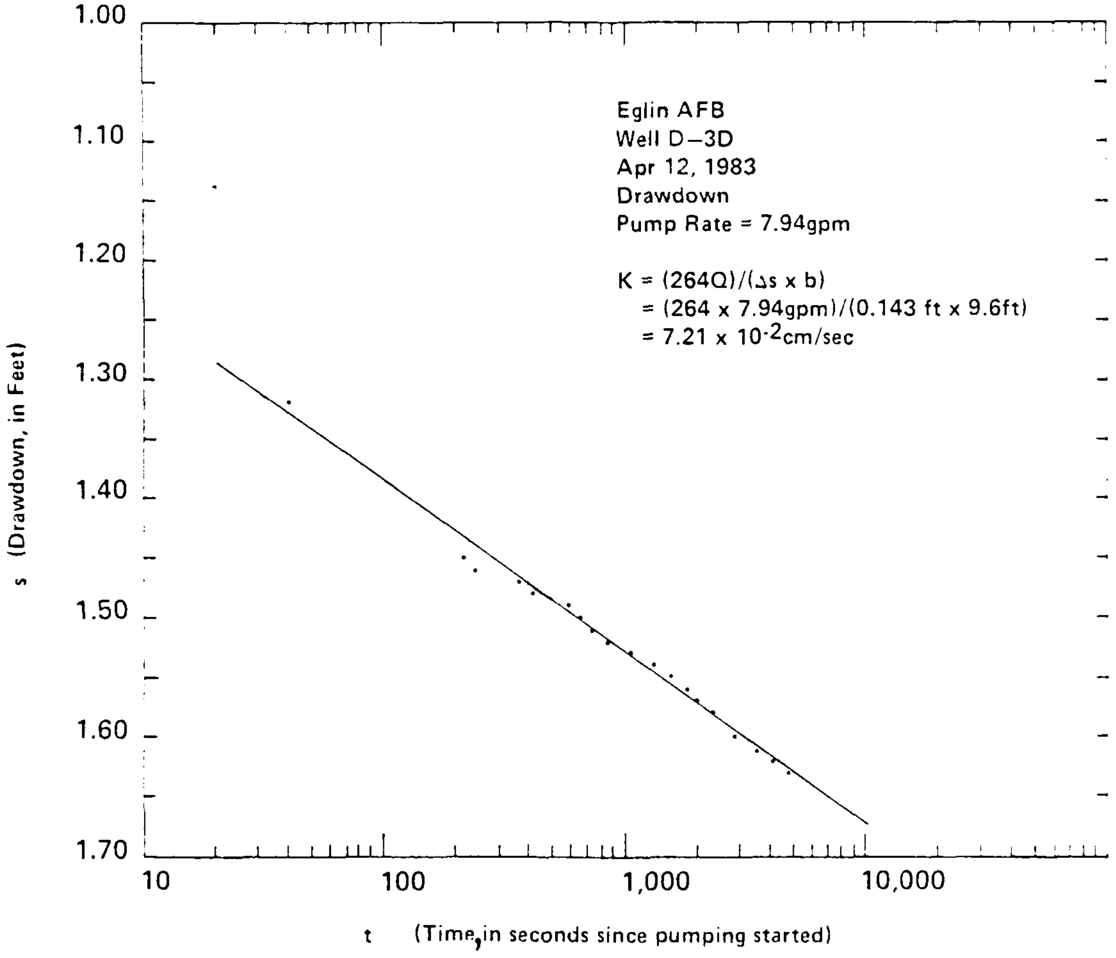


FIGURE A–2. Example of Plot of Drawdown Versus Time Since Pumping Started

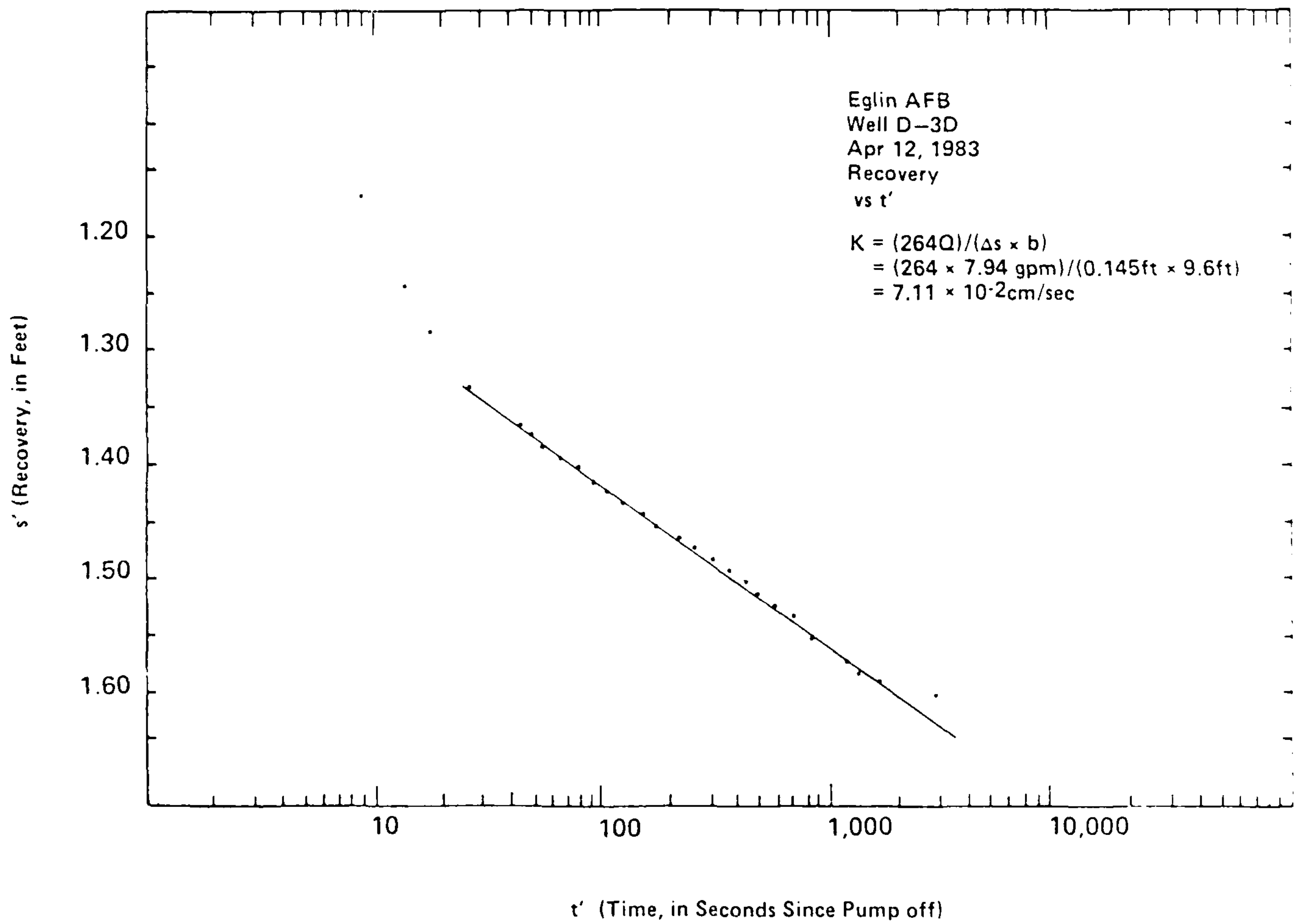


FIGURE A–3. Example of Plot of Recovery (s') Versus Time Since Pumping Stopped (t')

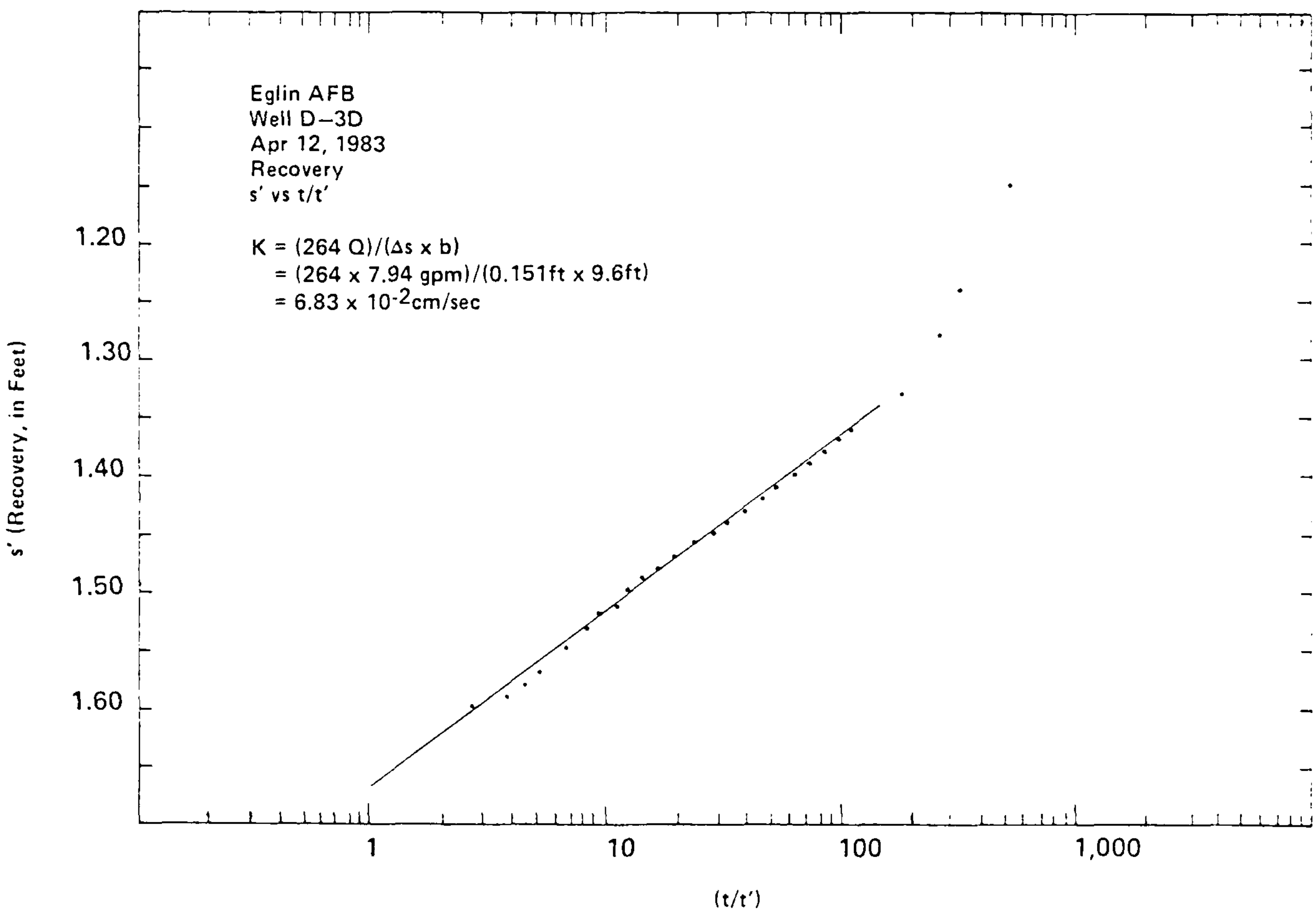


FIGURE A–4. Example of Plot of Recovery (s') Versus (Time Since Pumping Started)/(Time Since Pumping Stopped) (t/t')

A-3.2 FALLING HEAD TEST

WAR performed the falling head test at Eglin AFB by:

1. Determining the static water level by taking a series of preliminary water level measurements;
2. Rapidly filling the well with water; and
3. Measuring the decline in water levels as a function of time until the water levels returned to a static level.

Reduction of falling head test data was as follows:

1. Determine the time since the test started for each water level measurement, and
2. Calculate the difference (H_t) between each water level measurement and the static water level (H_o).

The data were plotted on semi-log paper as H_t/H_o vs t (Figure A-5). The straight line portion of the plot is used to determine hydraulic conductivity from the equation:

$$K = [R^2 \ln (L/R) \ln (H_1/H_2)]/[2L(t_2-t_1)]$$

where K = hydraulic conductivity (cm/sec),

R = inside diameter of the well casing (cm),

L = length of the well screen (cm),

t_1, t_2 = elapsed time (sec), and

$H_{1,2}$ = (Ht/Ho) at t_1 and t_2, respectively.

The value of hydraulic conductivity (2.45×10^{-4} cm/sec) determined at Well D-41D is within the range of values expected for a silty sand (Freeze and Cherry, 1979)[3].

---

[3]Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, N.J. p. 29.

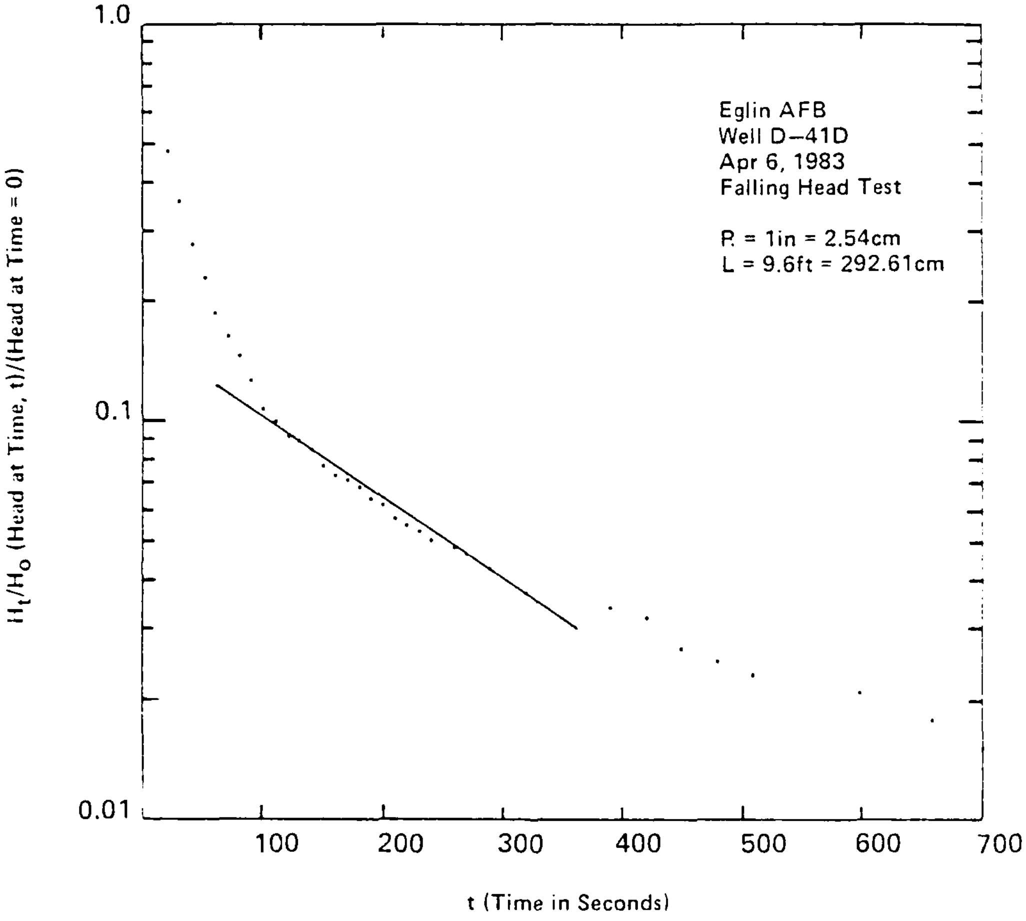


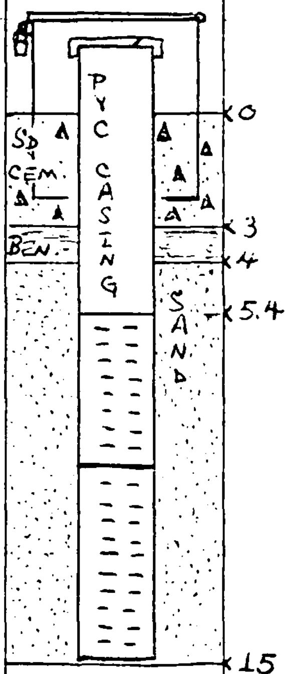
FIGURE A–5. Example of Plot of Falling Head Test Data

APPENDIX B

WELL DATA SHEETS

Boring No. B-1A
Hole Size 15 FT x 8 IN Slot 0.010 IN
Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC
Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC
Geologist W. D. ADAMS
Date Start 25 OCT 82 Finish 26 OCT 82
Contractor W.A.R. / W.T.D.
Driller PAUL WRIGHT

Location Coordinates N 543 480.70
E 1 370 217.50
Filter Materials NATIVE SAND
Grout Type SAND - CEMENT
Protective Casing 5 FT x 6 IN IRON
Static Water Level 7.15 FT T.O.C.
Top of Well Elevation 21.06 FT MSL
Drill Type 8 IN H.S.A. / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0 - 1.5 FT	SAND, COARSE TO MED (~90%), QTZ, ROUNDED, SPHERICAL, TR F. SD, SLT, TR. ORGANICS, GRAY (7.5 YR N4/) AND WHITE.	SP	2+4
		5 - 6.5 FT	SAND, COARSE TO MED (~95%), ~5% F. SD., QTZ, ROUNDED TO SUB-ANGULAR, SATURATED, WHITE.	SP	5+6
		10 - 11.5 FT	AS ABOVE.	SP	9+20
		15 FT	AS ABOVE.	SP	N.A.

SHEET 1 OF 1

Boring No. D-1B

Hole Size 15 FT x 8 IN Slot 0.010 IN

Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC

Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 26 OCT 82 Finish 26 OCT 82

Contractor W.A.R./W.T.D.

Driller P. WRIGHT

Location Coordinates N 543 144.96

E 1 371 619.87

Filter Materials NATIVE SAND

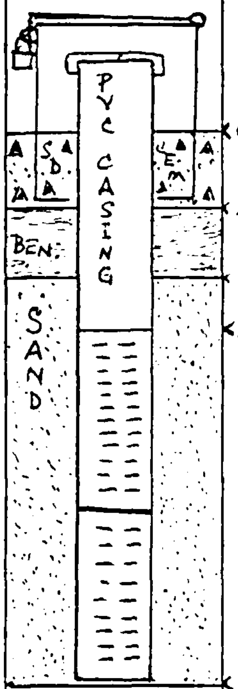
Grout Type SAND CEMENT

Protective Casing 5 FT x 6 IN IRON

Static Water Level 5.07 FT TOC

Top of Well Elevation 13.30 FT MSL

Drill Type 8 IN H.S.A./CME-55

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0 2.1 4 5.4 15	Ø-1.5FT	SAND, COARSE TO MED (~95%) TR. F. SD & SLT, TR SHELL FRAG, SD WELL ROUNDED & SPHERICAL, MOIST, V. PALE BRN (10YR 7/4)	SP	5+5
		5-6.5FT	SAND, MED (~90%), WELL ROUNDED & SPHERICAL, ~5% WOOD & PLANT FBR, TR F. SD - SLT, SATURATED, SO4 ODOR, LT YEL BRN (10YR 6/4).	SP	2+4
		10-11.5FT	SAND, COARSE TO MED (~95%), WELL-ROUNDED, TR PLANT FBR, SATURATED, SO4 ODOR, V. PALE BRN (10 YR 8/4).	SP	1+2
		15-16.5FT	SAND, F-MED, QTZ, WELL-ROUNDED, SATURATED, SO4 ODOR, V. PALE BRN (10 YR 8/4).	SP	8+17

SHEET 1 OF 1

Boring No. D-1C

Hole Size 15 FT x 8 IN Slot 0.010

Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC

Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 26 OCT 82 Finish 26 OCT 82

Contractor W.A.R. / W.T.D.

Driller PAUL WRIGHT

Location Coordinates N 740 637.74
E 1 375 531.83

Filter Materials NATIVE SAND

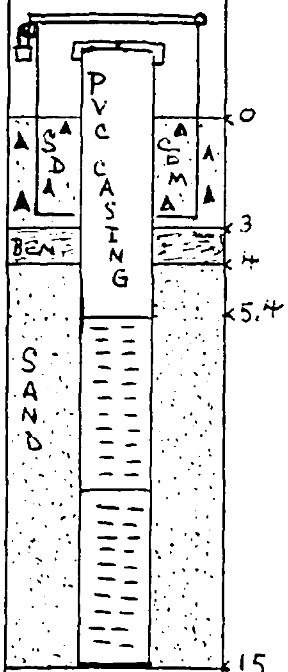
Grout Type SAND - CEMENT

Protective Casing 5 FT x 6 IN IRON

Static Water Level 6.09 FT TOC

Top of Well Elevation 7.04 FT MSL

Drill Type 8 IN HSA / CME - 55

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0 - 1.5 FT	SAND, V.F. TO F, ROUND, SPHERICAL, QTZ, TR SHELL AT SURFACE, TR. O.M., DRY, LT YEL BRN (2.5Y 6/4) AND LT GRAY (10YR 7/1).	SW	5+6
		5 - 6.5 FT	SAND, V.F. TO MED, ROUND, SPHERICAL QTZ, TR SH. FRAG, MOIST TO SATURATED, LT RED (2.5YR 6/8), & WHITE.	SW	3+5
		10 - 11.5 FT	SAND, AS ABOVE, SATURATED, V. DK. GRAY (7.5YR N3/). SO4 ODOR	SW	2+2
		15 - 16.5 FT	SAND, VF - F, TR SLT, ROUNDED TO SUB-ROUNDED, SATURATED, SO4 ODOR, V. PALE BRN (10YR 7/3).	SM	4+5

Boring No. D-1D

Hole Size 15 FT × 8 IN Slot 0.010 IN

Screen Size 9.6 FT × 2 IN Mat'l SCH 40 PVC

Casing Size 7.3 FT × 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 28 OCT 82 Finish 28 OCT 82

Contractor W.A.R. / W.T.D.

Driller P. WRIGHT

Location Coordinates N 539 306.93

E 1 374 618.78

Filter Materials NATIVE SAND

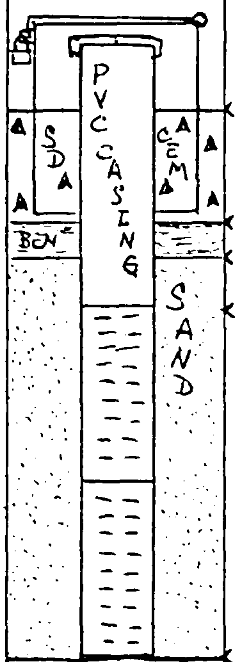
Grout Type SAND - CEMENT

Protective Casing 5 FT × 6 IN IRON

Static Water Level 6.19 FT T.O.C.

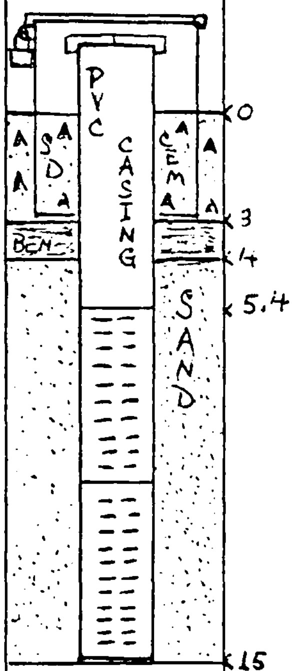
Top of Well Elevation 7.15 FT MSL

Drill Type 8 IN H.S.A. / CME-55

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0, 3, 4, 5.4, 15	0 - 1.5 FT	SAND, VF-F, QTZ, SUB-ANG, ~10% SLT & CLAY, TR ORG, DRY, BLACK.	SP-SM	5+5
		5 - 6.5 FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, SATURATED, WHITE (10 YR 8/1).	SP	4+6
		10 - 11.5 FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, TR SLT, SATURATED, PINK. GRAY (7.5 YR) 6/2).	SP	5+7
		15 - 16.5 FT	SAND, AS ABOVE.	SP	7+10

SHEET 1 OF 1

Boring No. D-2A	Location Coordinates N 539 613.69
Hole Size 15 FT x 8 IN Slot 0.010 IN	E 1 362 873.24
Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC	Filter Materials NATIVE SAND
Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC	Grout Type SAND CEMENT
Geologist W. D. ADAMS	Protective Casing 5 FT x 6 IN IRON
Date Start 27 OCT 82 Finish 29 OCT 82	Static Water Level 8.73 FT T.O.C.
Contractor W.A.R. / W.T.D.	Top of Well Elevation 23.02 FT MSL
Driller P. WRIGHT	Drill Type 8 IN H.S.A. / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	CLAYEY SAND, SAND, VF-F, QTZ, ANG., ~30% FINES, DRY, RED-YEL (7.5YR 7/8).	SC	7+5
		5-6.5FT	SAND, VF-M, QTZ, SUB-ANG, MOIST, WHITE.	SP	2+3
		10-11.5FT	SAND, AS ABOVE, SATURATED	SP	2+5
		15-16.5FT.	SAND, VF-F, QTZ, ANG TO SUB-ANG, ~5% SLT & CLAY, SATURATED, LT. GRAY (5Y 7/2)	SP-SM	3+2

SHEET 1 OF 1

Boring No. D-2B

Hole Size 15 FT x 8 IN Slot 0.010 IN

Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC

Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 27 OCT 82 Finish 29 OCT 82

Contractor W. A. R. / W. T. D.

Driller P. WRIGHT

Location Coordinates N 536 671.34
E 1361 665.93

Filter Materials NATIVE SAND

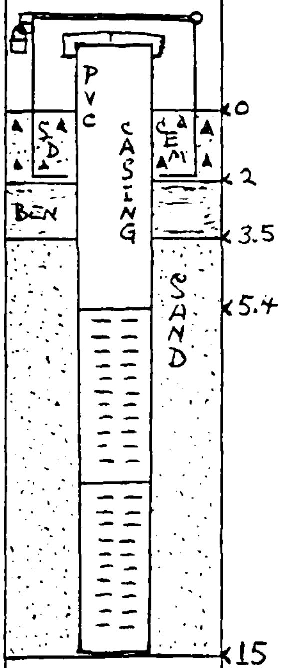
Grout Type SAND CEMENT

Protective Casing 5 FT x 6 IN IRON

Static Water Level 10.04 FT TOC

Top of Well Elevation 13.54 FT MSL

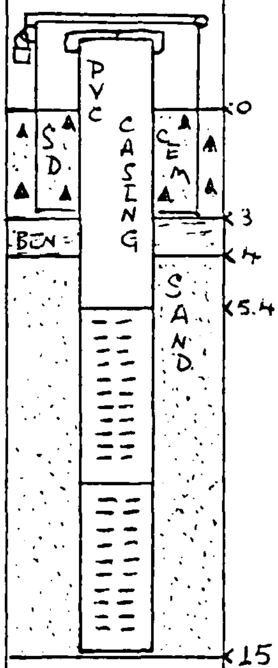
Drill Type 8 IN H.S.A. / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5 FT	SAND, VF-MED, QTZ, SUB-ANG., TR SLT, MOIST, YEL (10 YR 8/6) & WHITE (2.5Y 8/2).	SP	2+3
		5-6.5 FT	SAND, VF-F, QTZ, SUB-ANG, TR SLT & CLAY, MOIST, V. PALE BRN (10 YR 8/4).	SP	2+3
		10-11.5 FT	SAND, AS ABOVE, SATURATED, WHITE (10 YR 8/2).	SP	1+2
		15-16.5 FT	SAND, F-MED, TR VF & CRS, QTZ, SUB-ANG., SATURATED, V. PALE BRN (10 YR 8/3).	SP	6+3

SHEET 1 OF 1

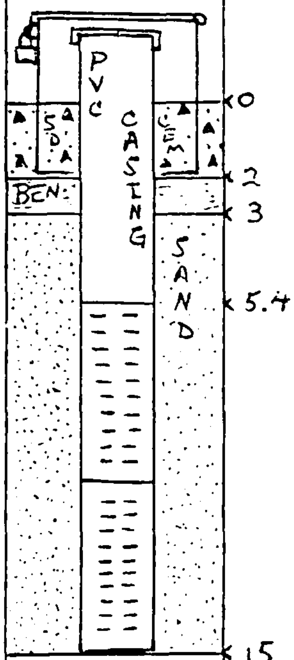
Boring No. D-2 C	Location Coordinates N 537 685.64
Hole Size 15 FT x 8 IN Slot 0.010 IN	E 1 360 520.64
Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC	Filter Materials NATIVE SAND
Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC	Grout Type SAND CEMENT
Geologist W. D. ADAMS	Protective Casing 5 FT x 6 IN IRON
Date Start 28 OCT 82 Finish 29 OCT 82	Static Water Level
Contractor W.A.R. / W.T.D	Top of Well Elevation 20.20 FT MSL
Driller P. WRIGHT	Drill Type 8 IN H.S.A. / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5 FT	SAND, VF-F, QTZ, SUB-ANG., TR SLT & CLAY, MOIST, WHITE (10 YR 8/2) AND YEL. (10 YR 8/6).	SP	1+1
		5-6.5 FT	SAND, VF-F, QTZ, SUB-ANG, ~10-15% SLT & CLAY, MOIST, YEL (10 YR 8/3)	SM	3+3
		10-11.5 FT	SAND, VF-M, QTZ, ANG TO SUB-ANG, TR SLT, SATURATED, WHITE	SP	3+3
		15-16.5 FT	SAND, VF-M, QTZ, SUB-ANG TO SUB-ROUND, TR SLT, SATURATED, WHITE.	SW	7+2

Boring No. D-2D
Hole Size 15 FT X 8 IN Slot 0.010"
Screen Size 9.6 FT X 2 IN Mat'l SCH 40 PVC
Casing Size 7.3 FT X 2 IN Mat'l SCH 40 PVC
Geologist W. D. ADAMS
Date Start 28 OCT 82 Finish 29 OCT 82
Contractor W.A.R. / W.T.D.
Driller P. WRIGHT

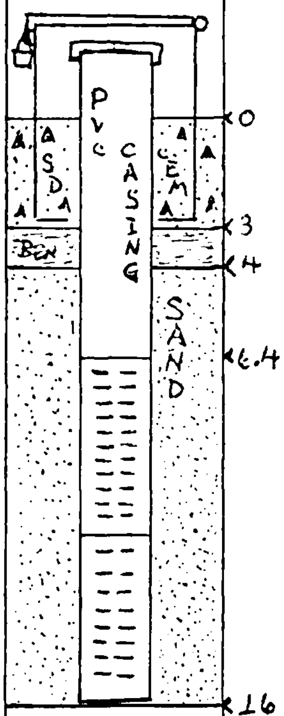
Location Coordinates N 538 341.71
E 1 361 270.54
Filter Materials NATIVE SAND
Grout Type SAND CEMENT
Protective Casing 5 FT X 6 IN IRON
Static Water Level 5.34 FT TOC
Top of Well Elevation 15.95 FT MSL
Drill Type 8 IN H.S.A. / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	SAND, VF-F, QTZ, SUB-ANG, MOIST, WHITE.	SP	1+2
		5-6.5FT	SAND, AS ABOVE, SOME PURPLE STAIN, SATURATED.	SP	5+2
		10-11.5FT	SAND, VF-CRS, QTZ, SUB-ANG TO SUB-ROUND, >60 % CRS SD, SATURATED, WHITE.	SP	29+14
		15-16.5FT	SAND, VF-M, QTZ, SUB-ANG TO SUB-ROUND, SATURATED, WHITE.	SW	45+47

SHEET 1 OF 1

Boring No.	D-3B	Location Coordinates	N 538 378.34
Hole Size	16 FT x 8 IN		E 1 366 648.32
Slot	0.010 IN	Filter Materials	NATIVE SAND
Screen Size	9.6 FT x 2 IN	Mat'l	SCH 40 PVC
Casing Size	8.3 FT x 2 IN	Mat'l	SCH 40 PVC
Grout Type	SAND CEMENT	Protective Casing	5 FT x 6 IN IRON
Geologist	W. D. ADAMS	Static Water Level	7.38 FT TOC
Date Start	27 OCT 82	Finish	27 OCT 82
Contractor	W. A. R. / W. T. D.	Top of Well Elevation	14.88 FT MSL
Driller	P. WRIGHT	Drill Type	8 IN HSA / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	SAND, F-VF, QTZ, SUB-ROUNDED TO SUB-ANGULAR, MOIST, V. PALE BRN (10 YR 8/4).	SP	1+2
		5-6.5FT	SAND, AS ABOVE, TR SH FRAG, ALMOST SATURATED, WHITE.	SP	2+4
		10-11.5FT	SAND, AS ABOVE, SATURATED, LT. YEL. BRN (10 YR 6/4).	SP	2+3
		15-16.5FT	SAND, AS ABOVE, SATURATED, WHITE	SP	27+10
		17 FT.	SAND, AS ABOVE, ~10% SLT & CLAY	SM	N/A.

Boring No. D-3C

Hole Size 15 FT x 8 IN Slot 0.010 IN

Screen Size 9.6 FT x 2 IN Mat'l SCH 40 PVC

Casing Size 7.3 FT x 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 27 OCT 82 Finish 27 OCT 82

Contractor WRIGHT TEST DRILL./WAR

Driller PAUL WRIGHT

Location Coordinates N 537 288.35

E 1 366 491.75

Filter Materials NATIVE SAND

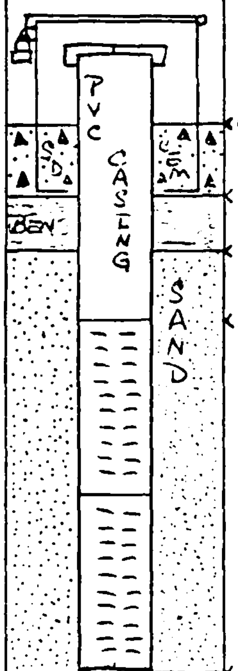
Grout Type SAND - CEMENT

Protective Casing 5 FT x 6 IN IRON

Static Water Level 6.59 FT TOC

Top of Well Elevation 14.65 FT MSL

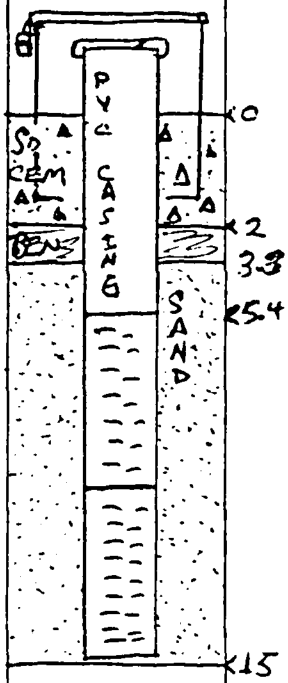
Drill Type 8 IN H.S.A. / CME-55

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0 2 3.5 5.4 15	0-1.5 FT	SAND, F-VF (95%), ~5% M-CRS, QTZ, SUB-ANGULAR TO SUB-ROUNDED, DRY, WHITE (10 YR 8/1).	SP	1+2
		5-6.5 FT.	SAND, VF-F (95%), TR M-CRS SD, QTZ ANGULAR, TR SLT, SATURATED, WHITE.	SP	2+3
		10-11.5 FT	SAND, VF-CRS, QTZ, SUB-ANG. TO SUB-ROUND, SATURATED, V. PALE BRN (10 YR 8/3).	SW	3+4
		15-16.5 FT	SAND, AS ABOVE.	SW	20+29

SHEET 1 OF 1

Boring No. D-3D
Hole Size 15FT x 8IN Slot 0.010"
Screen Size 9.6FT x 2IN Mat'l SCH 40 PVC
Casing Size 7.3FT x 2IN Mat'l SCH 40 PVC
Geologist W. D. ADAMS
Date Start 27 OCT 82 Finish 29 OCT 82
Contractor W.A.R. / W.T.D.
Driller P. WRIGHT

Location Coordinates N 537 697.19
E 1 367 078.49
Filter Materials NATIVE SAND
Grout Type SAND CEMENT
Protective Casing 5FT x 6IN IRON
Static Water Level
Top of Well Elevation 13.81 FT MSL
Drill Type CME-55; 8-IN HSA



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1½ FT	SAND, VF-F (90%), ~5% M, QTZ, SUB-ROUND, ~5% SLT, MOIST, LT. YEL. BRN. (10 YR 6/4).	SP	1+1
		5-6½ FT	SAND, VF-F (90%), QTZ, ANG. TO SUB-ROUND., ~10% SLT & CLAY, SATURATED, GRAY (5Y 6/1).	SM	1+2
		10-11½ FT	SAND, VF-M (>95%), QTZ, ANG. TO SUB-ROUND., TR SLT & CLAY, SATURATED, LT. BRN. GRAY (10 YR 6/2).	SP	5+7
		15-16½ FT	SAND, VF-M (~95%), QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, SATURATED, DK. GRAY. BRN (10 YR 4/2).	SP	13+13

SHEET 1 OF 2

Boring No. D-7A

Hole Size 55 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 29 OCT 82 Finish 29 OCT 82

Contractor W. A. R. / W. T. D.

Driller P. WRIGHT

Location Coordinates N 550 446.53

E 1 367 872.29

Filter Materials NATIVE SAND

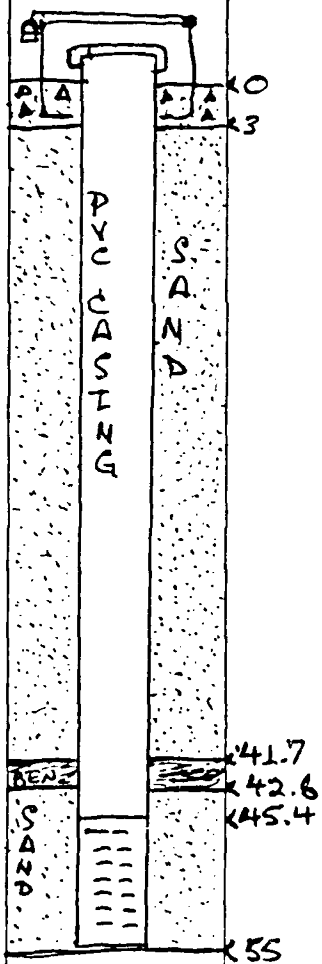
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 55.36 FT MSL

Drill Type CME-55; 8-IN HSA



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5 FT	SAND, VF-M, QTZ, SUB-ANG, ~5% SLT & CLAY, TR ORG, DRY, LT. BRN. GRAY (10 YR 6/2)	SW	2+1
		5-6.5 FT	SAND, VF-M, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, DRY, YELLOW (10 YR 7/8).	SW	3+3
		10-11.5 FT	SAND, VF-M, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, DRY, V. PALE BRN (10 YR 8/4).	SP-SW	3+3
		15-16.5 FT	SAND, AS ABOVE, DRY, WHITE AND RED-YEL (7.5 YR 7/8).	SP-SW	6+7
		20-21.5 FT	SAND, AS ABOVE.	SP-SW	4+6
		25-26.5 FT	SAND, AS ABOVE, DRY, WHITE STREAKED c̄ YELLOW (10 YR 8/8).	SP-SW	9+15
		30-31.5 FT	SAND, AS ABOVE.	SP-SW	11+11
		35-36.5 FT	SAND, VF-M (~95%), QTZ, SUB-ANG TO SUB-ROUND, ~5% SLT & CLAY, MOIST, YELLOW (10YR 7/8).	SW-SM	8+9
		37	SAND, CLAYEY, SAND, VF-M, QTZ, SUB-ANG, ~15% SLT & CLAY, MOIST, DARK GRAY (5 YR 4/1).	SC	N/A
		40-41.5 FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, DRY, WHITE STREAKED c̄ YELLOW (10 YR 8/8).	SP-SW	12+15
		45-46.5 FT	SAND, AS ABOVE, SATURATED, LT. GRAY (10 YR 7/2) AND YELLOW (10 YR 8/8).	SP-SW	12+18
		47	SAND, CLAYEY, SAND, VF-F QTZ ~25% CLAY & SLT, SATURATED, IN LUMPS 1/4 IN TO 2 IN, BLACK.	SC	N/A

Boring No. D- 7A

Hole Size ______ Slot ______

Screen Size ______ Mat'l ______

Casing Size ______ Mat'l ______

Geologist ______

Date Start ______ Finish ______

Contractor ______

Driller ______

Location Coordinates ______

Filter Materials ______

Grout Type ______

Protective Casing ______

Static Water Level ______

Top of Well Elevation ______

Drill Type ______

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		5Ø-51.5FT	SAND, VF-CRS, QTZ, SUB-ANG TO ROUND, ~5% CRS SD, ~10% SLT & CLAY, SATURATED, LT. GRAY (1Ø YR 7/2).	SP-SM	37+5Ø
		55-56½FT	SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CLAY, SATURATED, WHITE (2.5Y 8/2)	SP	18+22

SHEET 1 OF 1

Boring No. D-26A

Hole Size 15 FT x 8 IN. Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W.D. ADAMS

Date Start 2 NOV 82 Finish 2 NOV 82

Contractor W.A.R. / W.T.D.

Driller P. WRIGHT

Location Coordinates N 525 117.54

E 1 295 609.71

Filter Materials NATIVE SAND

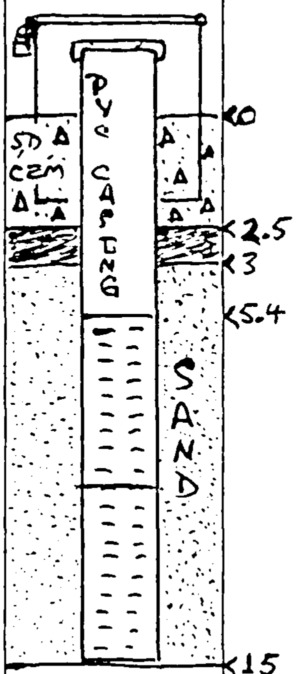
Grout Type SAND - CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

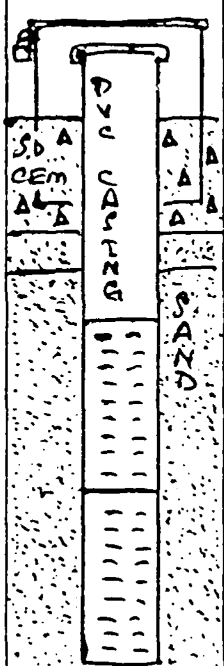
Top of Well Elevation 38.89 FT MSL

Drill Type CME-55; 8-IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	<u>SAND</u>, VF-F, QTZ, SUB-ANG, MOIST, V. PALE BRN (10 YR 8/4).	SP	1+1
		5-6.5FT	<u>SAND</u>, VF-F, QTZ, ANG, SATURATED, WHITE (10 YR 8/1).	SP	5+10
		10-11.5FT	<u>SAND</u>, AS ABOVE.	SP	8+8
		15-16.5FT	<u>SAND</u>, VF-F, QTZ, SUB-ANG, TR SLT & CLAY, SATURATED, SL. ODOR, V. DRK BRN (10 YR 2/2).	SP	

SHEET 1 OF 1

Boring No. D-26B	Location Coordinates N 525 851.99
Hole Size 15FT x 8IN Slot 0.010 IN	E 1 295 384.23
Screen Size 9.6FT x 2IN Mat'l SCH 40 PVC	Filter Materials "SP" SAND
Casing Size 2IN x 7.3FT Mat'l SCH 40 PVC	Grout Type SAND - CEMENT
Geologist W. D. ADAMS	Protective Casing 6 IN x 5FT IRON
Date Start 2 Nov 82 Finish 3 Nov 82	Static Water Level
Contractor W.A.R. / WRIGHT TEST.	Top of Well Elevation 35.16 FT MSL
Driller P. WRIGHT.	Drill Type 8 IN. HSA / CME - 55

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0 2 15	0-1.5FT	SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CLAY, MOIST, V. PALE BRN (10YR 8/4).	SP	3+4
		5-6.5FT	SAND, VF-F, QTZ, ANG, TR HVY MIN, SATURATED, WHITE.	SP	8+9
		10-11.5 FT	AS ABOVE, COLOR GRADES FROM WHITE TO V. PALE BRN (10YR 7/3) TO V. DK. GRAY (5Y 3/1).	SP	8+12
		15-16.5 FT.	SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CLAY, SATURATED, V. DK. GRAY. BRN. (10YR 4/2).	SP	20+50

SHEET 1 OF 1

Boring No. D - 26 C

Hole Size 15 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 3 NOV 82 Finish 3 NOV 82

Contractor W.A.R./W.T.D.

Driller P. WRIGHT

Location Coordinates N 525 976.32

E 1 295 651.77

Filter Materials "SP" SAND

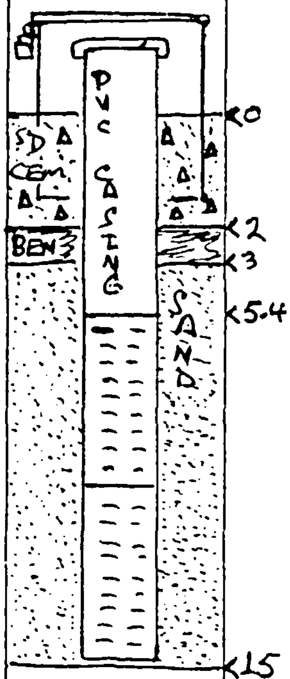
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 31.31 FT MSL

Drill Type CME-55; 8 IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5 FT	SAND, VF-F, QTZ, SUB-ANG, TR HVY MIN, TR ORG, ABNDNT PLNT FBR, MOIST, LT. GRAY (10 YR 7/1).	SP	2+2
		5-6.5 FT	SAND, VF-F, QTZ, SUB-ANG, TR HVY MIN, SATURATED, WHITE.	SP	3+8
		10-11.5 FT	AS ABOVE, ANG.	SP	20+27
		15 +	AS ABOVE. SAMPLED c̄ SAND BUCKET.	SP	N/A

SHEET 1 OF 1

Boring No. D-26 D

Hole Size 15 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 3 Nov 82 Finish 3 Nov 82

Contractor W.A.R. / W.T.D.

Driller P. WRIGHT

Location Coordinates N 525 772.33
E 1 296 146.65

Filter Materials "SP" SAND

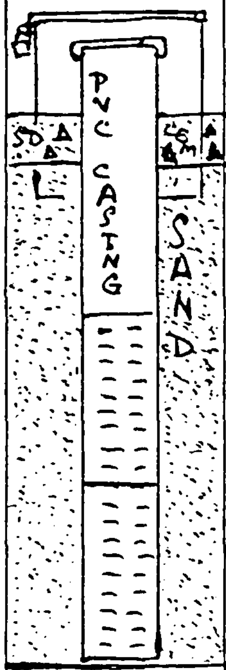
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 32.31 FT MSL

Drill Type CME - 55; 8 IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0, 1, 5.4, 15	0 - 1.5 FT	SAND, VF-F, QTZ, ANG, TR SLT & CLAY, ABNDNT PLNT FBRS, MOIST, DARK GRAY (10 YR 4/1).	SP	1+1
		5-6.5 FT.	NO RECOVERY, PROB. BRN SD.	N/A	3+4
		10-11.5 FT	SAND, VF-F, QTZ, SUB-ANG, TR SLT & CLAY, SATURATED, V. DARK BRN (10 YR 2/2).	SP	0+1
		15-16.5 FT	SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CLAY, SATURATED, BRN (10 YR 4/3).	SP	5+8

SHEET 1 OF 1

Boring No. D-41 A

Hole Size 15 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 1 NOV 82 Finish 1 NOV 82

Contractor W.A.R./W.T.D.

Driller P. WRIGHT

Location Coordinates N 524 397.97

E 1 298 219.31

Filter Materials NATIVE SAND

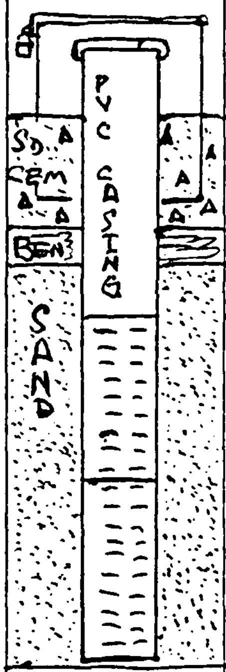
Grout Type SAND - CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

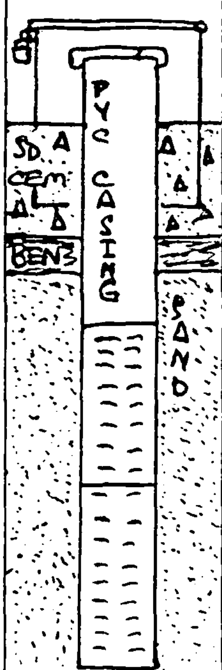
Top of Well Elevation 40.72 FT MSL

Drill Type CME-55; 8-IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0	0 - 1.5 FT	SAND, CLAYEY. SAND, VF-M, QTZ, WELL ROUNDED, ~20% SLT & CLAY, MOIST, DK. RED. BRN (5 YR 3/3) OVER SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CL, DRY, LT GRAY (10 YR 7/1).	SC SP	1+6
	2 2.6	5 - 6.5 FT	SAND, VF-F, QTZ, ANG. TO SUB-ANG., TR SLT & CLAY, SATURATED, WHITE.	SP	9+16
	5.4	10 - 11.5 FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, SATURATED, BRN (10 YR 5/3).	SP	5+5
		15 - 16.5 FT	SAND, VF-M, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, SATURATED, DK. GRAY. BRN (2.5 Y 4/2).	SP	7+9
	15				

SHEET 1 OF 1

Boring No.	D-41B	Location Coordinates	N 525 611.81
Hole Size	15 FT x 8 IN Slot 0.010"		E 1 298 577.45
Screen Size	2 IN x 9.6 FT Mat'l SCH 40 PVC	Filter Materials	NATIVE SAND
Casing Size	2 IN x 7.3 FT Mat'l SCH 40 PVC	Grout Type	SAND CEMENT
Geologist	W. D. ADAMS	Protective Casing	6 IN x 5 FT IRON
Date Start	2 NOV 82 Finish 2 NOV 82	Static Water Level	
Contractor	W.A.R./W.T.D.	Top of Well Elevation	36.14 FT MSL
Driller	P. WRIGHT	Drill Type	CME-55; 8-IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		SURFACE - 1.5FT	SAND, CLAYEY. SAND, VF-M, QTZ, WELL ROUNDED, ~15% SLT & CLAY, MOIST, REDDISH-YEL (7.5YR 7/8), ROAD CLAY.	SC	3+5
	<C		OVER SAND, VF-F, QTZ, WELL-ROUNDED, TR SLT & CLAY, TR ORG, MOIST, BLACK.	SP	
	<2 <2.8	5-6.5FT	SAND, VF-F, QTZ, ANG, TR SLT & CLAY, SATURATED, LT. GRAY (10YR 7/1).	SP	3+5
	<5.4	10-11.5FT	SAND, VF-F, QTZ, SUB-ANG, ~10% SLT & CLAY, ~10% ORG, SL. COHESIVE, SATURATED, BLACK (2.5YR 2/0).	SM	7+10
		15-16.5FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, ~10% SLT & CLAY, LOOSE, SATURATED, SL. ODOR, V. DK. GRAY. BRN. (10YR 3/2).		9+9
	<15				

SHEET 1 OF 1

Boring No. D-41 C

Hole Size 15 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 2 Nov 82 Finish 2 Nov 82

Contractor W.A.R. / W.T.D.

Driller P. WRIGHT

Location Coordinates N 525 577.06

E 1 292 670.69

Filter Materials NATIVE SAND

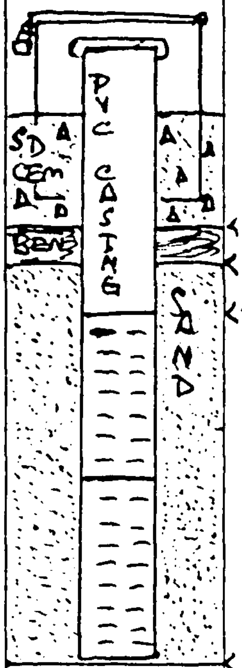
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 34.96 FT MSL

Drill Type CME 55; 8 IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	<2 <3.1 <5.4 <15	Ø-1.5FT	SAND, VF-F, QTZ, SUB-ANG TO SUB-ROUND, TR SLT & CLAY, SATURATED, LT. YEL. BRN. (2.5 Y 6/4).	SP	2+2
		5-6.5FT	SAND, SILTY. SAND, VF-F, QTZ, SUB-ROUND, ~10% SLT & CLAY, SATURATED, BLACK (2.5Y 2/0).	SP-SM	3+5
		1Ø-11.5FT	SAND, SILTY. SAND, VF-F, QTZ, SUB-ROUND, ~10% SLT & CLAY, TR ORG, SATURATED, SL. ODOR, V. DK. GRAY. BRN. (1Ø YR 3/2).	SP-SM	1Ø+15
		15-16.5FT	SAND, VF-F, QTZ, SUB-ROUND, TR SLT & CLAY, SATURATED, SL. ODOR, TR ORG, BRN. (1Ø YR 4/3).	SP	5+6

SHEET 1 OF 1

Boring No. D-41 D

Hole Size 15 FT x 8 IN   Slot 0.010"

Screen Size 2 IN x 9.6 FT   Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT   Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 2 NOV 82   Finish 2 NOV 82

Contractor W.A.R./W.T.D.

Driller P. WRIGHT

Location Coordinates N 525 604.39

E 1 298 760.80

Filter Materials NATIVE SAND

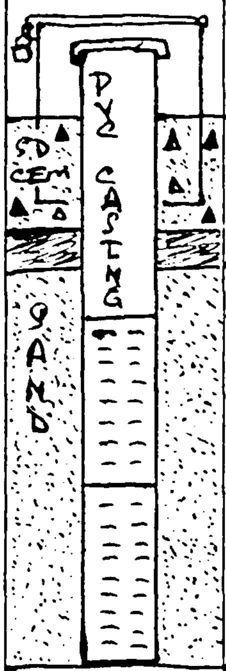
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 34.83 FT MSL

Drill Type CME-55; 8-IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		Φ-1.5FT.	SAND, VF-M, QTZ, ANG, DRY, ROAD FILL.	SP	5+6
	0	5-6.5FT	SAND, VF-F, QTZ, ANG TO SUB-ANG, SATURATED, TR SLT & CLAY, GRAY (10YR 5/1).	SP	5+5
	2	10-11.5FT	SAND, SILTY. SAND, VF-F, QTZ, SUB-ANG, ~15% SLT & CL, ~5% ROOTS, TR SH. FRAGS, SATURATED, DK. GRAY. BRN. (2.5Y 4/2).	SP-SM	7+8
	4				
	5.4	15-16.5FT	SAND, VF-F, QTZ, ANG TO SUB-ROUND, TR SLT & CLAY, TR ORG, SATURATED, DK. BRN (7.5YR 3/2).	SP	11+8
	15				

Boring No. D-4Ø A

Hole Size 16 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 4 Nov 82 Finish 4 Nov 82

Contractor W.A.R. / W.T.D.

Driller P. WRIGHT

Location Coordinates N 515 473.41

E 1 301 75[illegible].77

Filter Materials "SP" SAND

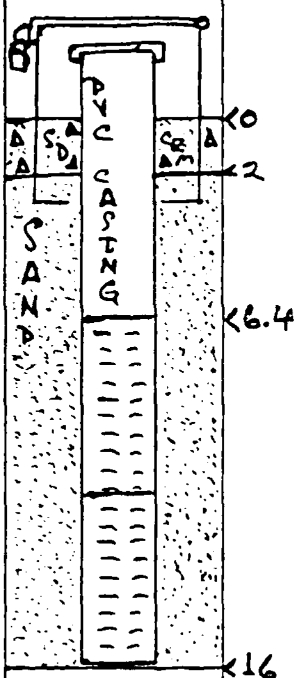
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 6.76 FT MSL

Drill Type CME 55; 8 IN HSA



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		Ø-1.5 FT	SAND, VF-F, QTZ, ANG, DRY, WHITE.	SP	2+2
		5-6.5 FT	AS ABOVE, ē TR HVY MIN, SATURATED.	SP	9+9
		1Ø-11½ FT	AS ABOVE.	SP	11+12
		15-FT+	AS ABOVE.	SP	N/A.

SHEET 1 OF 1

Boring No. D-40B

Hole Size 15 FT x 8 IN Slot 0.010"

Screen Size 2 IN x 9.6 FT Mat'l SCH 40 PVC

Casing Size 2 IN x 7.3 FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 4 Nov 82 Finish 4 Nov 82

Contractor W. A. R. / W. T. D.

Driller P. WRIGHT

Location Coordinates N 516 022.06
E 1 302 695.90

Filter Materials "SP" SAND

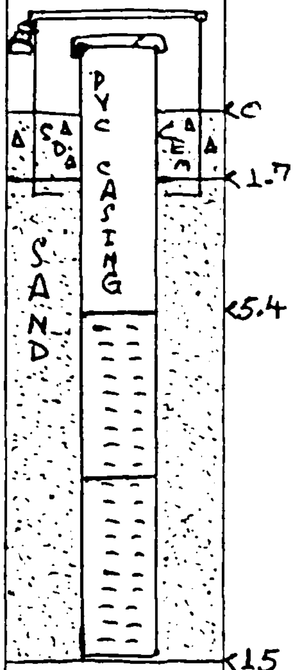
Grout Type SAND CEMENT

Protective Casing 6 IN x 5 FT IRON

Static Water Level

Top of Well Elevation 6.35 FT MSL

Drill Type 8-IN HSA / CME-55



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	SAND, VF-F, QTZ, ANG, TR SLT & CLAY, PLNT ROOTS, DRY, LT. GRAY (10 YR 7/1).	SP	1+1
		5-6.5FT	SAND, VF-F, QTZ, ANG, TR HVY MIN, TR PLNT ROOTS, SATURATED, WHITE.	SP	2+2
		10-11.5FT	AS ABOVE, LT. BRN. GRAY (10 YR 6/2).	SP	1+2
		15FT +	AS ABOVE.	SP	N/A

SHEET 1 OF 1

Boring No. D-4Ø C

Hole Size 14.7FT x 8IN Slot 0.010"

Screen Size 2IN x 9.6FT Mat'l SCH 40 PVC

Casing Size 2IN x 7.3FT Mat'l SCH 40 PVC

Geologist W. D. ADAMS

Date Start 4 Nov 82 Finish 4 Nov 82

Contractor W.A.R./W.T.D.

Driller P. WRIGHT

Location Coordinates N 516 248.31

E 1 302 539.41

Filter Materials "SP" SAND

Grout Type SAND CEMENT

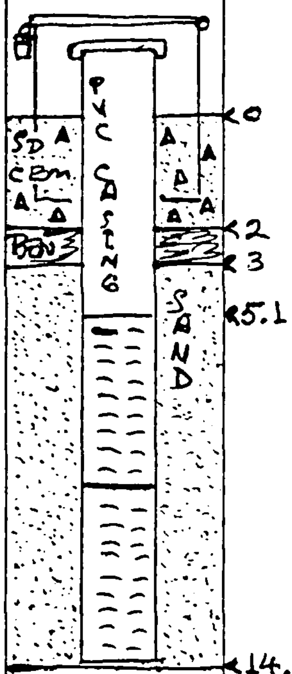
Protective Casing 6IN x 5FT IRON

Static Water Level

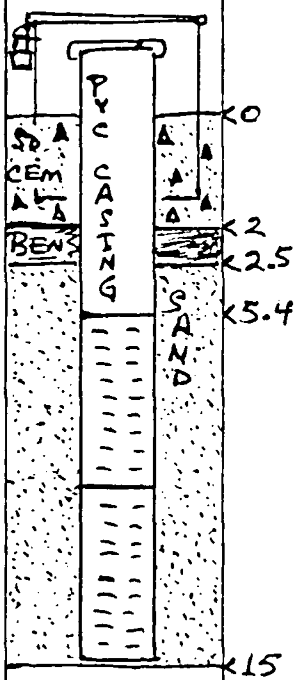
Top of Well Elevation 7.85 FT MSL

Drill Type CME-55 / 8IN HSA

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		Ø-1.5FT	SAND, VF-F, QTZ, ANG, TR HVY MIN, DRY, WHITE.	SP	1+2
		5-6.5FT	AS ABOVE, SATURATED.	SP	4+5
		1Ø-11.5FT	AS ABOVE.	SP	1Ø+14
		15FT +	AS ABOVE.	SP	N/A



Boring No. D-40D		Location Coordinates	N 516 124.92
Hole Size 15FT x 8IN	Slot 0.010"		E 1 302 395.02
Screen Size 2IN x 9.6FT	Mat'l SCH 40 PVC	Filter Materials	"SP" SAND
Casing Size 2IN x 7.3FT	Mat'l SCH 40 PVC	Grout Type	SAND CEMENT
Geologist W. D. ADAMS		Protective Casing	6IN x 5FT IRON
Date Start 4 NOV 82	Finish 4 NOV 82	Static Water Level	
Contractor W.A.R. / W.T.D.		Top of Well Elevation	5.28 FT MSL
Driller P. WRIGHT		Drill Type	CME-55 / 8IN HSA



Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
		0-1.5FT	SAND, VF-F, QTZ, ANG, TR HVY MIN, SATURATED, WHITE.	SP	1+1
		5-6.5FT.	AS ABOVE, LT BRN.	SP	1+2
		7 FT +	SAND, PEATY. SAND, VF-F, QTZ, ANG C̄ ~30-40% FIBROUS PEAT SATURATED, DK BRN (10YR 3/3)		N/A
		10-11.5FT	SAND, VF-F, QTZ, ANG, TR HVY MIN SATURATED, LT GRAY (10YR 7/2)	SP	1+2
		15-16.5FT	AS ABOVE.	SP	11+16

APPENDIX C

LABORATORY METHODS AND FIELD QUALITY ASSURANCE

APPENDIX C

LABORATORY METHODS AND FIELD QUALITY ASSURANCE

C-1.0 ANALYTICAL RATIONALE

No method for qualitative or quantitative determination of any specific analyte is applicable to all samples, but, when possible, a EPA approved method was the method of choice. If there was no EPA method or if it was inappropriate due to the nature of the sample, a method from Standard Methods for the Examination of Water and Wastewater by the American Public Health Association was used. Lacking an appropriate methodology from these two sources, methods were either obtained from scholarly publications or were developed in the WAR laboratory. In some cases, two or more similar accepted methods have been consolidated to produce higher-quality data from the samples being examined. In all cases, quality control assurances were incorporated into the analyses to evaluate the quality of data produced.

The remainder of this appendix will either cite or describe the methods used to obtain chemical data during this investigation, and outline the quality assurance/quality control (QA/QC) procedures directly relevant to the Eglin AFB Phase IIb survey.

C-2.0 SAMPLING INSTRUCTIONS FOR EGLIN AFB

Descriptions of sample containers, preservation methods, and holding times are given in Table C-5. Sampling procedures are outlined below for each analysis group.

C-2.1 PURGEABLE ORGANICS

This sample should come from the first aliquot of a bailer to prevent the loss of any volatiles. Avoid excess turbulence (e.g., bubbling) when filling these bottles for the same reason. Fill bottle to an inverted meniscus, cap, and refrigerate immediately. A small convex dimple in the top of the septum indicates that the bottle is properly filled. There should be no air bubbles present in the bottle. This sample is taken in triplicate in 40 milliliter glass, screw-cap vials with Teflon™ septa. Preservation is by refrigeration.

C-2.2 METALS

Metal samples from the wells should be from the first bailer (1 liter) to minimize the amount of silt collected in the sample. Bottles should be filled to the very top if dissolved metals are desired and filtration is not performed immediately.

Filtration should be as follows:

1. Rinse a glass fiber filter with 20 to 30 milliliters of 0.5 N HNO_3 after placing the filter in the suction apparatus. Discard the rinsate.
2. Rinse the filter with 20 to 30 milliliters of sample. Discard the rinsate.
3. Filter the sample and return it to the bottle after rinsing the bottle with deionized water.
4. For membrane filtration, place the filter in the filtration apparatus with the gridded side up and follow steps 1 through 3; preserve the sample with concentrated HNO_3.
5. Samples must be filtered through the 0.45-micrometer filter for analytes to be considered dissolved. Filtration through a glass fiber filter reduces "binding" of the membrane filter but may not be needed for samples with little turbidity.

After filtration, preserve metal samples by adding 2 milliliters of HNO_3 per liter of sample. Mix thoroughly and check the pH by pouring a small amount of the sample on a pH test strip. If the pH is not less than 2, add more HNO_3. Refrigeration of preserved metals samples is not necessary.

C-2.3 ORGANIC CARBON

Fill the sample bottle completely to ensure sufficient volume if sample is to be filtered. The filtration procedure is the same as that for metals except 5 N H_2SO_4 is used for rinsing and concentrated H_2SO_4 is used for preservation. These samples require refrigeration.

C-2.4 OIL AND GREASE

Due to the nature of analyte, do not fill sample bottles completely. Bottles are 1-liter amber glass with foil-lined caps. Preserve oil and grease samples by adjusting the pH below 2 with concentrated HCl and refrigerating the sample.

C-2.5 PHENOLICS

Do not fill bottles completely in order to leave room for spiking purposes. Preserve with concentrated H_3PO_4 (using disposable glass pipets) to a pH <2. Add 1 gram of $CuSO_4$ per liter of sample. Refrigerate after acidification.

C-2.6 TOX

The procedure is the same as that used for purgeable organics except the sample is taken in duplicate.

C-2.7 PCBs/PESTICIDES AND HERBICIDES

Use 1-quart glass jars with metal or Teflon™-lined caps for PCB/pesticide samples. Take care in sampling surface waters to prevent inclusion of excessive amounts of silt and debris disturbed from the bottom at the site. Preserve these samples by refrigeration.

C-2.8 pH AND SPECIFIC CONDUCTANCE

Meters were standardized daily in the field using solutions prepared in the WAR laboratory. Back-up meters and solutions were available at all times in the company vehicle on-site.

C-3.0 ANALYTICAL QUALITY CONTROL

All field sampling and quality control spiking was performed by WAR. All sample analyses, with the exception of TOX, TOC, and phenolics, were performed by the WAR laboratory. TOX analyses were performed by Harmond Engineering, CH_2M Hill tested for phenolics, and TSI determined organic carbon. Each of the above organizations maintains a strict quality assurance/quality control (QA/QC) plan which is outlined in a separate document. These QA/QC documents were not appended in this report due to their length.

Accuracy of analytical techniques is assured by strict adherence to the methods listed in Tables C-1, C-2, and C-3 and outlined in Methods Descriptions 1 and 2. Integrity and representativeness of the sample are assured by sampling procedures described in Appendix A-2.0. A check on analytical quality control was provided by duplicating a minimum of 10 percent of the samples in each analysis lot. Additional samples were collected to provide for spiking 10 percent of total phenolics, organochlorine pesticides, herbicides, and PCB samples. Samples for TOC, TOX, metals, oil and grease, volatile aromatics, and volatile halocarbons were not spiked. Duplicate and spike samples were labeled in such a way that the analytical laboratory could not identify them. Results of duplicate and spike analyses are shown in Table C-4.

Table C-1. Analytical Chemistry Methods for Water Samples, Eglin AFB

Parameter	Method
pH*	EPA 150.1
Specific conductance*	EPA 120.1
Temperature*	EPA 170.1
Organic carbon	EPA-415.1
Total organic halide	EPA 450.1†
Oil and grease	EPA-413.1
Phenolics	EPA-420.2
Herbicides	Analytica Chemica Acta 131:307
Organochlorine pesticides/PCBs	EPA 608**
Arsenic	EPA 206.2
Cadmium	EPA-213.2
Chromium	EPA-218.2
Cobalt	EPA 219.2
Lead	EPA-239.2
Mercury	EPA-245.1
Nickel	EPA 249.2
Selenium	EPA-270.3
Silver	EPA-272.2
Zinc	EPA 289.1
Purgeable organics	EPA 624

NOTE: EPA = U.S. EPA "Methods for Chemical Analysis of Water and Wastes," March 1979-Method number.

*Performed at the time of sample collection.
†Interim Method, November 1980, EMSL, Physical and Chemical Methods Branch, Cincinnati, Ohio 45268.
**EPA = EPA "Methods for Organic Chemical Analysis of Municipal & Industrial Wastewater," July 1982-Method number.

Table C-2. Analytical Chemistry Methods for Soil and Sediment Samples, Eglin AFB

Parameter	Method
Pesticide/PCBs	EPA/COE - 3-307 and EPA Sed - 198-207, 144-183, 651-732, 210-219 Modified
Oil and grease	EPA Sed-739
Herbicides	Analytica...Modified (see Table C-1)

NOTE: EPA Sed = EPA "Chemical Laboratory Manual for Bottom Sediments and Elutriate Testing," EPA-905/4-79-014, March 1979a-Central Regional Laboratory Methods Number.

EPA/COE = Plumb, R.H., Jr. 1981. "Procedure for Handling and Chemical Analysis of Sediment and Water Samples," Technical Report EPA/CE-81-1, prepared by Great Lakes Laboratory, State University College at Buffalo, Buffalo, New York, for the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. Published by the U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi

Table C-3. Elution Pattern of Organochlorine Pesticides/PCBs and Organophosphate Pesticides from Florisil

Percent Ethyl Ether in 200 ml Petroleum Ether Fraction		
6%	15%	50%
-BHCs	Endosulfan I	Endosulfan II
Heptachlor	Dieldrin	Endosulfan sulfate
Aldrin	Endrin	Malathion
Chlordanes	Endrin aldehyde	
Heptachlor epoxide	Methyl parathion	
DDT-R	Ethyl parathion	
Mirex		
Methoxychlor		
Toxaphene		
PCBs		

Sources: Federal Register. 44(233):69504. Monday, December 3, 1979. EPA Method 608.

EPA. H.E.R.L. 1979. "Manual for Analytical Quality Control for Pesticides and Related Compounds in Human and Environmental Samples." Research Triangle Park, NC. Revised.

Table C-4. Results of Past Duplicate and Spiked Samples (Page 1 of 4)

Analyte	Month/Year Sampled	Dup 1	Dup 2	Spike Conc.	% Rec.
Phenolics	11/82	<1	1	11	108
	11/82	3	5	55	93
	11/82	6	8	28	101
	2/83	<1	<1	14	66
	2/83	6	7	11	71
	2/83	<1	3	29	97
	2/83	<1	<1	55	103
2,4-D	11/82	<3	<3	1.4	35
	11/82	<3	<3	7.2	89
	11/82	<3	<3	14.4	78
	2/83	<3	<3	--	--
	2/83	<3	<3	--	--
	2/83	<3	--	74.9	93
	2/83	<3	--	143	87
	2/83	--	--	6.8	41
	2/83	<3	--	10.3	63
Silvex	11/82	<2	<2	2.3	91
	11/82	<2	<2	11.6	100
	11/82	<2	<2	23.3	86
	2/83	<2	<2		
	2/83	<2	<2		
	2/83	<2	--	124	96
	2/83	<2	--	241	92
	2/83	<2	--	21.7	81
	2/83	<2	--	21.6	82
TOC (mg/l)	11/82	<1	2	--	--
	11/82	156	201	--	--
	11/82	90	73	--	--
DOC (mg/l)	2/83	24	21	--	--
	2/83	15	15	--	--
	2/83	16	11	--	--
	2/83	28	26	--	--
Oil and grease (gravimetric, mg/l)	11/82	<5	<5	--	--
	11/82	<5	<5	--	--
	11/82	<5	<5	--	--
	2/83	<5	5	--	--
	2/83	<5	7	--	--
	2/83	<5	<5	--	--
	2/83	<5	<5	--	--

Table C-4. Results of Past Duplicate and Spiked Samples (Page 2 of 4)

Analyte	Month/Year Sampled	Dup 1	Dup 2	Spike Conc.	% Rec.
Aldrin	2/83	ND	ND	0.3	74
	11/82	ND	ND	6	103
Endosulfans	2/82	ND	ND	0.3	78
-BHC	2/82	ND	ND	0.3	65
Dieldrin	2/82	ND	ND	0.5	73
Endrin	2/82	ND	ND	2.0	73
Endrin aldehyde	2/82	ND	ND	0.4	45
DDT-R	11/83	ND	ND	0.6	>90
PCB (Aroclor 1248)	11/83	ND	ND	70	91
Toxaphene	11/83	ND	ND	50	92
Chlordane	11/83	ND	ND	16	109
-BHC	11/83	ND	ND	6	107
TOX	11/82	<50	60	--	--
	11/82	<50	<50	--	--
	11/82	140	120	--	--
	2/83	<50	<50	--	--
	2/83	<50	80	--	--
	2/83	<50	<50	--	--
	2/83	<5	<50	--	--
Purgeables	11/82	ND	ND	--	--
	11/82	ND	ND	--	--
	11/82	ND	ND	--	--
	2/83	ND	ND	--	--
	2/83	ND	ND	--	--
	2/83	ND	ND	--	--
	7/83	ND	ND	--	--
	7/83	ND	ND	--	--
	7/83	ND	ND	--	--
As	11/82	<10	<10	--	--
	11/82	193	256	--	--
	2/83	<2	<2	--	--
	2/83	<2	2	--	--
Cd	11/82	7	3	--	--
	11/82	2	<1	--	--
	2/83	<0.2	<0.2	--	--
	2/83	1.1	0.7	--	--

Table C-4. Results of Past Duplicate and Spiked Samples (Page 3 of 4)

Analyte	Month/Year Sampled	Dup 1	Dup 2	Spike Conc.	% Rec.
Cr	11/82	<10	<10	--	--
	11/82	90	89	--	--
	2/83	<2	<2	--	--
	2/83	<2	<2	--	--
Co	11/82	<10	<10	--	--
	11/82	59	60	--	--
	2/83	<5	<5	--	--
	2/83	<5	<5	--	--
Pb	11/82	25	<25	--	--
	11/82	29	<25	--	--
	2/83	<5	<5	--	--
	2/83	<5	<5	--	--
Hg	11/82	<2	<2	--	--
	11/82	<2	<2	--	--
	2/83	<0.2	<0.2	--	--
	2/83	<0.2	<0.2	--	--
Ni	11/82	<10	12	--	--
	11/82	69	73	--	--
	2/83	<2	<2	--	--
	2/83	<2	<2	--	--
Ag	11/82	<1	<1	--	--
	11/82	<1	<1	--	--
	2/83	<0.5	<0.5	--	--
	2/83	<0.5	<0.5	--	--
Zn	11/82	50	20	--	--
	11/82	90	70	--	--
	2/83	10	20	--	--
	2/83	20	20	--	--
2,4-D	11/82	ND	ND	--	--
(Sediment)	11/82	ND	ND	--	--
Silvex	11/82	ND	ND	--	--
(Sediment)	11/82	ND	ND	--	--

Table C-4. Results of Past Duplicate and Spiked Samples (Page 4 of 4)

Analyte	Month/Year Sampled	Dup 1	Dup 2	Spike Conc.	% Rec.
Oil and grease	11/82	<200	<200	--	--
(Sediment)	11/82	<200	<200	--	--
(mg/kg dry weight)					
DOC (mg/l)	7/83	71	69	--	--
	7/83	42	42	--	--
	7/83	71	54	--	--
	7/83	57	49	--	--
	7/83	55	69	--	--

Reported in ug/l unless otherwise noted.
ND = None detected.

Table C-5. Sample Containers, Preservation Methods, and Holding Times

Parameter	Sample Type	Container/ Volume	Method of Preservation (Filtration, pH, etc.)	Holding Time
Oil and grease	W*	Glass, 1 qt.	Conc. HCl to pH <2, chill to 4°C	28 days
Phenolics	W	Glass, 1 qt.	Conc. H_3PO_4 to pH <2, 1 gram $CuSO_4$/L, chill to 4°C	28 days
Dissolved metals	W	Plastic, 1 qt.	Filter, conc. HNO_3 to pH <2	6 months
TOX	W	Glass, 8 oz. (2) Teflon™ septa	No headspace in vial, chill to 4°C	14 days
DOC	W	Plastic, 4 oz. or 2 oz.	Filter, conc. H_2SO_4 to pH <2, chill to 4°C	28 days
Purgeables	W	Glass, 40 ml (3) Teflon™ septa	No headspace in vial, chill to 4°C	14 days
Pesticides/ PCBs	W	Glass, 1 qt.	Chill to 4°C	7 days extraction, 40 days analysis
Herbicides	W	Glass, 1 qt.	Chill to 4°C	7 days extraction, 40 days analysis
Pesticides, PCBs herbicides, oil and grease	S	Glass, 1 qt.	Chill to 4°C	Same as for water samples

*W=Water; S=Sediment

Source: EPA, 1982 (water only).

METHOD DESCRIPTION 1
PROCEDURE FOR THE FLORISIL CLEANUP OF ORGANOCHLORINE PESTICIDES/PCBs IN WATER, SOIL, OR SEDIMENT EXTRACTS

Introduction

A full-scale Florisil cleanup of an organic extract serves a twofold purpose: (1) removal of highly pigmented, polar, oily, or acidic compounds; and (2) separation of compounds which interfere with each other in the analysis by GC (primarily the Chlordane-DDT group and the Dieldrin-Endrin-Endosulfans group). The former can be accomplished using a scaled-down version of this cleanup if the sample extract is not too heavily loaded with contaminants. However, the latter is dependent upon the specific absorption capacity of the Florisil, and the amount used has to be calculated according to this activity. The lauric acid value is a measure of this absorption capacity and can be used to determine the required amount of Florisil needed for the separation (see Standardization of Florisil).

Procedure

1. Prepare the chromatographic columns by placing a small piece of glass wool in the bottom of the tube and slurry packing the Florisil charge with petroleum ether or hexane.

2. Add 1 to 2 centimeters of anhydrous Na_2SO_4 to the top of the column and drain off the excess solvent used in packing, but leave a small amount to cover the Na_2SO_4 cap. Discard the eluate. Place Kuderna-Danish concentration apparatus equipped with a 10 milliliter receiver under the column.

3. Introduce the sample extract with a transfer pipette into the Na_2SO_4 on the top of the column. The sample should be introduced with the smallest volume of solvent possible, but be sure to rinse the receiver vessel containing the extract and add this to the column also. This rinse can be used to rinse the walls of the column above the sulfate layer as the sample elutes into the column.

4. As soon as the sample has completely eluted into column, pour the first elution fraction into the reservoir of the column and elute at 5 milliliter/minute (see Table C-3 for the elution pattern of organochlorine pesticides/PCBs from Florisil).

5. When the last few milliliters of the first fraction have reached the sulfate layer, remove the Kuderna-Danish apparatus and place an empty apparatus under the column. Pour the next fraction into the reservoir and continue the elution. In eluting the last fraction, the column may be allowed to go to dryness. NOTE: The flow may be stopped briefly to change Kuderna-Danish apparatii.

6. Concentrate the various fractions with Macro-Snyder column technique to ≤ 5 milliliter. Make to volume with isooctane and analyze by GC.

METHOD DESCRIPTION 2

METHOD FOR DETERMINATION OF ORGANO-CHLORINE PESTICIDES, PCB's, PRIORITY POLLUTANTS IN SOIL AND BOTTOM SEDIMENTS

1. Accurately weigh out approximately 50-100 grams (depending on the moisture content) of sample in a porcelain crucible which has been suitably cleaned. If a dry soil sample, transfer directly to a pre-extracted Soxhlet thimble. Rinse the crucible and spatula used in transferring with a portion of the extracton solvent and proceed to step 3. If the sample is a bottom sediment or very moist, decant off the supernatant water before weighing and mix well to obtain a homogenous sample. A representative sample should be weighed, but large rocks, sticks and other extraneous material should not be included. If it is difficult to obtain a representative aliquot, duplicate or triplicate analyses should be conducted and averaged for more accurate results. A second aliquot of approximately 10 grams is weighed in an aluminum weigh dish for moisture determination.

2. For sediment samples let the weighed portion air dry for 24-72 hours and then add a 25 g portion of anhydrous sodium sulfate to remove the remaining moisture before transferring to the extraction thimble. After mixing the sample and Na_2SO_4 let it stand covered for 15-30 minutes. Then transfer the sample to the thimble and wipe any remaining sample into the thimble with a plug of glass wool. This glass wool can then be used as the cap in the thimble. Rinse the crucible and spatula with a portion of the extraction solvent.

3. Place the thimble in the extraction apparatus (Soxhlet) using care not to spill any of the contents into the reservoir area. A small piece of glass wool at the entrance to the siphon tube will prevent it from being clogged by any spilled material.

4. Join the extractor to the receiver, which contains 200-300 ml of 50:50 Acetone:Hexane (nanograde) and several Teflon boiling chips. Reflux at 55°C for 4-8 hours (more time is needed for clay-like soils).

5. Filter the extract through anhydrous Na_2SO_4 into a Kuderna-Danish concentrator equipped with a 10 ml receiver. Rinse the extraction thimble with approximately 50 ml of fresh extraction solvent and flush through the siphon tube. Filter this rinse into the K-D apparatus also.

6. Concentrate the sample to $\leq$5 ml and perform a Florisil cleanup on the extract.

Sources: EPA "Chemical Laboratory Manual for Bottom Sediments and Elutriate Testing," EPA-905/4-79-014, March 1979, RL Nos. 198-207, 144-183, 651-732, 210-219.

EPA, "Manual of Analytical Methods for the Analysis of Pesticide Residues in Human and Environmental Samples," H.E.R.L./ETD, Contract No. 68-02-2474, Revised: June 1977.

APPENDIX D

RESUMES

WILLIAM D. ADAMS

HYDROGEOLOGIST
WATER AND AIR RESEARCH, INC.

Relevant Experience

Mr. Adams has experience in the geohydrologic monitoring of hazardous waste sites, geotechnical evaluation of power plant sites, and assessment of environmental impacts of surface mining operations. He supervised the construction of ground-water monitoring wells for both the environmental survey and the decontamination study of the Alabama Army Ammunition Plant. He recently completed work at Langley Air Force Base in Virginia, where he was responsible for installation and sampling of monitoring wells at several locations suspected of contamination. He also supervised surface water and sediment sampling at this base. Mr. Adams also has participated in geotechnical studies for Soyland Power Cooperative's new coal-fired power plant and in power plant siting studies for the Tampa Electric Company. He has served as hydrogeologist on deep sewage injection well construction projects and on the construction and testing of water supply wells. Other experience includes studies of coastal processes near inlets, coastal zone management, pumping station siting, and the geologic history of lakes.

Education

M.S.	Geology	University of Florida
B.S.	Geology	University of Florida

Professional Societies

National Water Well Association
Florida Water Well Association

Publications

Adams, W.D. 1976. The Geologic History of Crescent Lake, Florida. Master's Thesis. University of Florida, Gainesville, Florida.

Mehta, A.J., C.P. Jones, and W.D. Adams. 1975. John's Pass and Blind Pass--Glossary of Inlets Report. Florida Sea Grant Program.

Mehta, A.J., W.D. Adams, and C.P. Jones. 1975. Sebastian Inlet--Glossary of Inlets Report. Florida Sea Grant Program.

Walton, Todd, and W.D. Adams. 1976. The Capacity of Outer Inlet Bars to Store Sand. In: Proceedings of the Coastal Engineering Conference, Honolulu, Hawaii.

ROBERT D. BAKER, JR.

CHEMIST
WATER AND AIR RESEARCH, INC.

Relevant Experience

Mr. Baker has diverse experience in analyzing environmental samples for various organic constituents. Examples of his work include:

- o Gas chromatographic (GC) analysis using FID, ECD, NPD, FPD, and Hall ECD; and high pressure liquid chromatographic (HPLC) analysis using variable wavelength UV/visible, fluorescence, and electrochemical detectors; and

- o Developing and testing methods for analysis for determining trace levels of organic contaminents in pesticide industry wastestreams which included, among other analysis, detecting phenolics and volatiles using GC.

In work related to other pesticide manufacturers, he reviewed and assessed processes for more than 200 compounds. Using plant operating data, he identified possible impurities introduced via raw materials, by-products created from side-reactions, and potential contamination from various solvent media. This work ultimately led to development of pretreatment technologies.

Mr. Baker modified existing methods of analyzing for DDT in natural waters. Modification was necessary to meet extremely low detection limits with rigorous quality control, because of low concentrations mandated in drinking water regulations. He validated a proposed haloether analysis method for Battelle. To accomplish this, he conducted GC analysis on and assessed resulting data for spiked samples of wastewater and distilled water.

Other types of analytic work by Mr. Baker include:

- o Analyzing natural water (river and lake) samples for organics for background EIS data for projects in Georgia, South Carolina, Alabama, and Florida;

- o Developing improved techniques to accurately measure volatile hydrocarbon levels in soils in Virginia;

- o Analyzing fish tissue for hazardus waste contamination in blinded samples with better than 90 percent accuracy on duplicates and controls in Alabama;

- o Using HPLC to verify methods for analysis of 16 polynuclear aromatic hydrocarbon compounds and two benzidine compounds for wastewater matrix from sites in Ohio; and

- o Using HPLC to develop methods and analyze for hazardous (munitions) wastes from sites in Louisiana and Texas.

Education

B.S.	Chemistry	Northeast Louisiana University

Professional Societies

American Chemical Society
American Association for the Advancement of Science

CHARLES R. FELLOWS

CHEMIST
WATER AND AIR RESEARCH, INC.

Relevant Experience

Mr. Fellows is responsible for WAR's water chemistry laboratory. He oversees the laboratory operation, scheduling and coordinating the flow of samples through the lab, and maintaining the quality assurance program. He is familiar with the COE/EPA procedures for the collection and analysis of water and sediment samples. He has also contributed directly to lake restoration projects by determining the hydraulic and nutrient loadings from seepage into three Florida lakes. He has established seepage monitoring programs and was a co-author of a report to the Corps of Engineers on nitrogen and phosphorus loading characteristics of the Lake Conway ecosystem.

Education

M.S.	Water Chemistry	University of Florida
B.S.	Biology	Eckerd College

Publications

Co-author of Interim Report on the "Nitrogen and Phosphorus Loading Characteristics of the Lake Conway, Florida, Ecosystem." Tech. Report A-78-2. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. 41 pp.

Author of "The Significance of Seepage in the Water and Nutrient Budgets of Selected Florida Lakes." Master's Thesis. University of Florida. 1978 (unpublished). 140 pp.

Co-author of "Seepage Flow into Florida Lakes." Water Resources Bulletin, August 1980, 16:635-641.

Co-author of "Fertilizer Flux into Two Florida Lakes via Seepage." Journal Environmental Quality, 1981, 10:174-177.

Co-author of "Nitrogen and Phosphorus Dynamics of the Lake Conway Ecosystem: Loading Budgets and a Dynamic Hydrologic Phosphorus Model." Final Report. U.S. Army Corps of Engineers. Waterways Experiment Station, Vicksburg, MS. 1979. (in press).

JERRY A. STEINBERG, Ph.D., P.E.

WATER RESOURCES ENGINEER
WATER AND AIR RESEARCH, INC.

Relevant Experience

Dr. Steinberg is an environmental engineer specializing in defining pollutant transport. He has studied water quality in lakes and rivers as well as in confined and unconfined aquifers throughout the southeast.

He has conducted studies of nonpoint source pollution which included field monitoring, loads projections, and control recommendations. He performed a comprehensive appraisal of groundwater quality data for the sole source Biscayne Aquifer, a significant geohydrologic resource. His analysis (among other factors) contributed to recent designations of areas protecting groundwater.

In a study of groundwater contamiantion, Dr. Steinberg conducted well monitoring near freshwater lakes in Florida. Impacts of land uses on groundwater quality and pollutant movement were determined.

In Dade County, Florida, he performed a study of groundwater contamination from disposal of a proposed hazardous waste. Wells were sited and installed, sampling directed, and results interpreted. Evidence of pollutant movement beyond property boundaries was shown; however, hazardous constituents did not migrate far in the aquifer. Mitigation recommendations were made.

Dr. Steinberg has conducted numerous briefings before citizens groups, technical committees, and political bodies regarding cause and effect of pollution in both groundwater and surface waters.

For the U.S. Army, he conducted field studies of dispersion of munitions wastes in surface waters. For the Corps of Engineers, he collected water quality data and pollutant dispersion of data in Apalachicola Bay (FL).

Dr. Steinberg is currently an officer of the ASCE Hazardous Wastes Management Committee, and recently played a key role in developing a policy statement concerning proposed Superfund legislation.

Education

Ph.D.	Environmental Engineering	University of Florida
M.S.E.	Water Resources Engineering	Vanderbilt University
B.C.E.	Civil Engineering	Vanderbilt University

JAMES H. SULLIVAN, JR., Ph.D., P.E.

ENVIRONMENTAL ENGINEER
WATER AND AIR RESEARCH, INC.

Relevant Experience

Dr. Sullivan is an environmental and chemical engineer experienced in water resource studies and in environmental inventories and assessments. He has managed the physical systems portions of over 25 interdisciplinary inventory and impact assessment projects over the past 11 years. Physical systems include air quality, noise, water quality, hydrology, geohydrology, etc. These projects have been at various locations throughout the United States.

Dr. Sullivan has diverse experience in the environmental engineering aspects of toxic wastes. He has directed several studies of the water quality impacts of munitions wastes for the U.S. Army. His work included field monitoring, data analysis, development of statistical analysis methods, and interpreting elaborate biologic and bioassay data. He has also performed investigations involving the disposal of various industrial solid wastes in Kansas, Tennessee, Florida, Mississippi, and Texas. This work included determining the environmental impact of existing waste disposal practices followed by the development and evaluation of alternative control methods.

Expert testimony has been given by Dr. Sullivan on many occasions. He has testified as witness for both regulatory agencies and permit applicants (in different instances). Among issues adjudicated were stormwater runoff from agricultural lands, water quality impacts of aggregate mining, and wastewater discharge impacts on receiving streams.

Dr. Sullivan also planned and managed a study for an industrial firm to determine the extent and impact of deleterious sediments on water quality in a tidal embayment. The work plan called for investigation, evaluation, and recommendations for corrective action. The study, which was part of a court settlement, required that the results be reviewed and agreed to by both industry and regulatory personnel. This was accomplished.

Education

Ph.D.	Environmental Engineering	University of Florida
M.S.	Environmental Engineering	University of Florida
B.S.	Chemical Engineering	Georgia Institute of Technology

Professional Registrations

Registered Professional Engineer in Florida.

Publications

Author and co-author of publications in water chemistry, potable water treatment, wastewater renovation, and environmental impact assessment.

APPENDIX E

SAFETY PLAN

APPENDIX E
SAFETY PLAN

E-1.0 GENERAL

The safety plan presented herein gives guidelines for basic safety procedures and equipment utilized by WAR during the course of the IRP Phase II surveys. Samples collected during the Phase II surveys are typically environmental water and sediment samples as opposed to hazardous waste samples and normally do not require unusual levels of personnel protection. Detailed procedures and equipment required to minimize exposure to specific hazardous wastes or conditions requiring higher levels of protection are beyond the scope of this plan. References are provided from which waste-specific information on equipment and procedures can be obtained on a case-by-case basis.

E-2.0 INFORMATION REVIEW

Prior to initiating the Phase II survey field work, the Phase I records search is reviewed in detail to identify hazardous wastes or conditions that may be encountered at each site. Available toxicological data on materials suspected of being present at the sites are reviewed to determine if the base level of personnel protection outlined in Section E-5.0 is adequate. Hazards such as the presence of highly toxic or incompatible chemicals, toxic gases, radioactive material, or explosives may require more extensive precautionary measures than the base level of protection. Safety hazards requiring special attention are addressed on an individual basis using appropriate assessment methods, and equipment and procedure recommendations given in the EPA Field Health and Safety Manual (EPA, 1980) and the EPA Safety Manual for Hazardous Waste Site Investigations (EPA, 1979). Hazardous conditions can be clarified or confirmed on preliminary site visits.

E-3.0 MEDICAL MONITORING PROGRAM

The person responsible for the Phase II survey field work will determine whether a medical monitoring program is necessary, based on results of the information review. If hazard levels are judged high enough to warrant this procedure, all field personnel will participate in a medical monitoring program. Guidelines for the program are given in Appendix I of the EPA Field Health and Safety Manual (EPA, 1980).

E-4.0 FIELD PERSONNEL INDOCTRINATION

All field personnel will be informed by the project field supervisor of required safety equipment and procedures prior to on-site work. Subjects covered will include personal safety gear, general and site-specific safety procedures, and incident notification procedures.

E-5.0 PERSONNEL PROTECTION GEAR

The following items will be provided on-site for all field personnel:

- o Tyvek® disposable coveralls,
- o Rubber boots,
- o Rubber gloves,
- o Hard hats,
- o Eye protection (safety glasses or face shields).

Hearing protection (disposable ear plugs) will be provided for all work in the vicinity of the flight line or other noise hazards. Cartridge-type respirators will be available on-site for protection against inhalation of dust or vapors. If strong vapors are encountered, respirators will be utilized to facilitate evacuation of personnel and equipment from the site until the situation can be assessed or corrected.

Personal equipment described above will offer adequate protection for most situations encountered during the course of the Phase II survey field work. When conditions are identified that require a higher level of personal protection, the EPA Safety Manual for Hazardous Waste Site Investigations will be referred to for guidance.

E-6.0 SAFETY PROCEDURES

Hard hats and eye protection will be worn when appropriate, as directed by the project field supervisor. Protective clothing (boots, gloves, and coveralls) will be worn at all times while working on-site. Coveralls will be changed a minimum of once daily.

The project field supervisor will consult with the base environmental coordinator or other responsible contact regarding site-specific hazards prior to entering sites. Special procedures for entering and working at particular sites will be clarified and conveyed to all field personnel. Examples of areas requiring strict procedures are active runways or taxiways, fuel handling or storage areas, and secure areas.

Prior to any drilling or digging on the sites, USAF Form 103 must be routed to all applicable base organizations for a clearance review. Circulation of this form is required to avoid contact with underground or overhead utilities, conflict with base activities, or breaches of security.

Additional safety procedures will be implemented, if warranted by the information review or conditions encountered at the site. Site-specific safety procedures will be based on guidelines given in the EPA Field Health and Safety Manual and the EPA Safety Manual for Hazardous Waste Site Investigations.

E-7.0 INCIDENT/ACCIDENT NOTIFICATION PROCEDURES

As a minimum, the following emergency phone numbers should be available on-site:

1. Ambulance or medical assistance,
2. Base fire department (or other if off-site), and
3. USAF contact for project.

After contacting appropriate emergency services, or in nonemergency incidents, the USAF project contact should be notified of the incident or accident so that it can be dealt with according to base policies and procedures.

APPENDIX F

LIST OF ACRONYMS

APPENDIX F
LIST OF ACRONYMS

AFB	Air Force Base
AFFF	Aqueous film forming foams
cm	Centimeter
Cl^-/l	Chloride per liter
COD	Chemical oxygen demand
DOC	Dissolved organic carbon
EOD	Explosive Ordnance Disposal
FAC	Florida Administrative Code
FDER	Florida Department of Environmental Regulation
FDA	Food and Drug Administration
HPLC	High performance liquid chromatography
IRP	Installation Restoration Program
msl	Mean sea level
ug/kg	Micrograms per kilogram
ug/l	Micrograms per liter
mg/kg	Milligrams per kilogram
mg/l	Milligrams per liter
OD	Outside diameter
OEHL	Occupational and Environmental Health Laboratory
ppm	Parts per million
PCB	Polychlorinated biphenyl
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
TSI	Technical Services, Inc.
TOC	Total organic carbon
TOX	Total organic halogens
USAF	United States Air Force
EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
umhos	Micromhos
VOA	Volatile aromatics
VOH	Volatile halocarbons
WAR	Water and Air Research, Inc.